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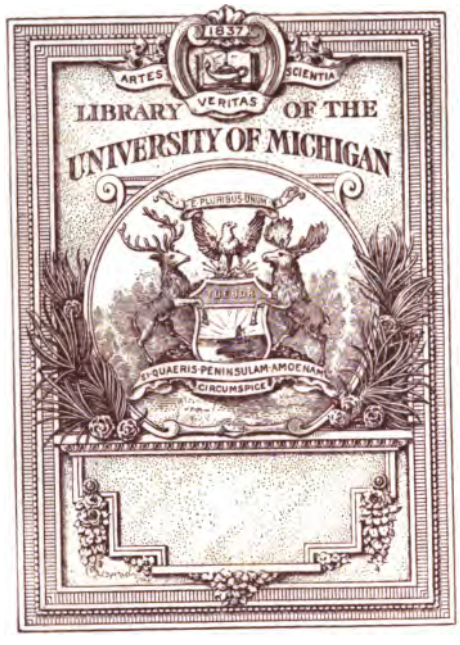
FORESTRY

INDIANA

1906



THE GIFT OF
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View of large shade trees planted on the public highway near Plymouth, Ind. This row of trees was saved from destruction by the ruthless linemen by the owner's resorting to the most vigorous means of protection.

STATE OF INDIANA

SIXTH ANNUAL REPORT

OF THE

State Board of Forestry

1906

W. H. FREEMAN, Secretary

To the Governor of Indiana

INDIANAPOLIS, INDIANA

INDIANAPOLIS:
WM. B. BURFORD, CONTRACTOR FOR STATE PRINTING AND BINDING.
1906.

THE STATE OF INDIANA,
EXECUTIVE DEPARTMENT,
INDIANAPOLIS, December 1, 1906.

Received by the Governor, examined and referred to the Auditor of State for verification of the financial statement.

OFFICE OF AUDITOR OF STATE,
INDIANAPOLIS, December 17, 1906.

The within report, so far as the same relates to moneys drawn from the State Treasury, has been examined and found correct.

J. C. BILLHEIMER,
Auditor of State.

December 17, 1906.

Returned by the Auditor of State, with above certificate, and transmitted to Secretary of State for publication, upon the order of the Board of Commissioners of Public Printing and Binding.

FRED L. GEMMER,
Secretary to the Governor

Filed in the office of the Secretary of State of the State of Indiana, December 17, 1906.

FRED A. SIMS,
Secretary of State.

Received the within report and delivered to the printer December 17, 1906.

HARRY SLOUGH,
Clerk Printing Bureau.

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Indiana State Board of Forestry.

OFFICIAL MEMBERS, 1906.

FINLEY C. CARSON, President ..... Michigan City.
STANLEY COULTER ..... Lafayette.
LARKIN M. STULTZ..... Westfield.
SAMUEL BURKHOLDER..... Crawfordsville.
WM. H. FREEMAN, Secretary ..... Wabash.
AMY STOOPS, Stenographer..... Wabash.

Office of Secretary.

Room 93, State House, Indianapolis.

STATE OF INDIANA, BOARD OF FORESTRY,

Indianapolis, December 1, 1906.

HON. J. FRANK HANLY, *Governor:*

Dear Sir—In accordance with the legal requirement, we have the honor to submit herewith the manuscript of the Sixth Annual Report for the Department of Forestry. It contains papers of discussion and explanation of the work accomplished by the Board in different sections of the State, of the work accomplished at the Forest Reservation and Experimental Station, Clark County, Indiana, and of the field work of the assistant, Benjamin W. Douglass.

We desire to thank you for your courtesy, ready co-operation and sincere interest in the cause represented by this Department, and assure you it is a work which is constantly advancing and becoming a most important institution, affecting as it does the whole institutional life of the State.

We have the honor to be, with great respect,

Yours very truly,

F. C. CARSON, President.

W. H. FREEMAN, Secretary.

Preface.

The advance of forestry in all its features during the past year gives promise of future success for the cause. The sentiment for a stronger forestry movement by the people of Indiana is rapidly and surely increasing. As has been the fact since the establishment of the Department, the best thinking people everywhere are giving it their candid and earnest thoughts. It but remains for the State to give its full encouragement and co-operation and forestry as a civic and economic institution with the people will become positive.

The exact extent of the accomplishments in forestry in the State are not known. Statistics taken with the best care and completeness which the Statistical Department can command fail to show anything like the actual facts. The thing most needed by the Forestry Department is a competent field assistant backed by sufficient funds to enable him to do systematic forestry work and make complete investigations in the different counties. The best work along the line of the farm wood-lot can only be accomplished by such means.

The Board under its present attainment can not give the right attention to personal systematic work in the different counties, and consequently a great amount of work in forestry which is sought to be done is either not accomplished at all or if so is poorly performed. The Secretary in addition to the office duties has personal supervision of the Forest Reservation and Experimental Station and the lecture and literary features also must be cared for by him. Something must be neglected, as one individual can not do all there is to be done and do it rightly.

A splendid field assistant is recommended by the Board to carry forward the systematic organization of forestry in the counties. The Department is surely accomplishing a good work, but no department of any kind can do the things it should as a department and the things actually required of it unless it is given the support

with which to accomplish its aims and purposes in the best manner. The growth and development of forestry in Indiana is such as to require a field assistant, and the addition of this one small feature will add an hundred fold to the completeness and effectiveness of the work being done.

It is also further suggested by the Board that it be given more power to control corporations from the destruction of shade and ornamental trees along the highways and in the cities and towns throughout the State where adequate park officers are lacking. Suitable laws should be enacted fully restraining any individual or corporation from injury to such trees and power vested in the Board to compel compliance therewith. The ruthless disregard which is being shown daily by the destruction of trees, both along the highways and on private property by corporate individuals, is conducive of mob violence. The picture shown in the frontispiece of this report is that of a row of trees along the highway, and were only spared from the ruthless lineman by the owner resorting to shotgun vigilance. Such a course for the protection of property is deplorable, yet common decency has been so outraged by such instances of vandalism to trees along the highways that it is time to call a halt.

The Board expresses its kindest appreciation of the public press for its united support of the cause of forestry. Not many contributions, however, were offered the past year from the office, but it was from a lack of time to prepare them and not from any other cause. To the public spirited citizens the Board urges the same continued thought and conduct toward the advancement of the cause as has been made manifest during the past years. It suggests, however, that less attention be devoted to foreign and experimental species of tree planting and more thought given to the planting of home trees, the success and values of which are known. Also it is further suggested that the wood-lot as herein discussed be made a subject of earnest consideration by all land owners.

STATE BOARD OF FORESTRY.

Financial Statement.

November 1, 1905, to October 31, 1906.

1. ANNUAL APPROPRIATIONS BY ACTS OF GENERAL ASSEMBLY.

Office—		
Salary, Secretary of Board	$1,800 00	
Salary, Stenographer of Secretary	600 00	
Salary, four Board Members for one year at $100 each, plus one month to even fiscal year by State Auditor	433 32	
Mileage, four Board Members for one year	125 82	
General Office Expense Fund	1,000 00	
Total		$3,959 14
Forest Reservation and Experimental Station—		
Labor and general management	$3,000 00	
Total		$3,000 00

2. SPECIFIC APPROPRIATION BY GENERAL ASSEMBLY, 1905.

For Forest Reservation and Experimental Station—Improvements:		
Forest cultivation	$1,800 00	
Field planting	720 00	
Field cultivation	900 00	
Total		$3,420 00
Total of all appropriations		$10,379 14

EXPENDITURES.

Office—Salaries:		
W. H. Freeman, Secretary of Board	$1,800 00	
Ella Grow, Stenographer, five months	250 00	
Amy Stoops, Stenographer, seven months	350 00	
Finley C. Carson, Board member	108 33	
Stanley Coulter, Board member	108 33	
Larkin M. Stultz, Board member	108 33	
Samuel Burkholder, Board member	108 33	
Finley C. Carson, mileage for year	59 10	
Stanley Coulter, mileage for year	22 20	
Larkin M. Stultz, mileage for year	20 52	
Samuel Burkholder, mileage for year	24 00	
Total		$2,959 14

Office—General Expenses:		
Mileage and livery, Secretary	$272 83	
Postage	225 00	
Field work	289 70	
Photography	25 26	
Telephone, rents and tolls	123 50	
Blue prints	11 35	
Notary fees	5 00	
Stationery and printing	18 52	
Stenography, extra	7 00	
Telegraphy	25	
Expressage	9 14	
Horticultural meeting	11 92	
Balance unexpended	53	
Total		$1,000 00
Forest Reservation and Experimental Station—		
Management and general expense	$839 39	
Labor	2,160 22	
Balance unexpended	39	
Total		$3,000 00
Improvements—		
Forest cultivation, labor	$1,811 71	
Field cultivation, labor	900 00	
Field planting, labor	350 00	
Seeds	378 67	
Total		$3,440 38
Overdraft—Forest Cultivation:		
Expense Fund, and refunded by Secretary of Board	$11 71	
Overdraft—Field Planting:		
Expense Fund and refunded by Secretary of Board	8 67	
Total		$20 38
Total expenditure by State for improvements		$3,420 00
Total of expenditures by State	$10,378 22	
Total balance unexpended	92	
Total		$10,379 14

Revenues received from Forest Reservation and Experimental Station and remitted to State Treasurer upon recommendation of State Auditor:

Sales of wood	$499 48	
Sales of lumber	173 93	
Sales of cross-ties	711 86	
Sales of spoke blocks	89 91	
Sales of fruit	4 50	
Field rents	54 59	
Total		$1,534 27

Report of Work Accomplished by the Office the Past Year.

The work performed in forestry by the office the past year was similar in character to that of former ones. The efforts were directed toward stimulating interest in forest preservation and systematic forest cultivation of farm wood-lots, commercial plantings on the cheaper lands, shade and ornamental tree planting, and general tree culture. These features of forestry were promoted by visits and inspections and written recommendations made for both private and corporate interests. The plans of education, as in former years, were continued by means of lectures before public gatherings and by the distribution of literature by mail and express. Less of newspaper contributions were made than formerly, from the facts as stated in the "preface" of this report. The office work the past year was confined to two principal things, the office work proper and the work at the Forest Reservation and Experimental Station. The increase in the details of these two duties of the Secretary demanded that they be given the emphasis of attention, and consequently the field work had to be attended to by correspondence for the greater part, and much of it omitted. More good forestry work would have resulted if the field work in the different counties of the State had been given the proper attention, but the office and Experimental Station would have been neglected.

Correspondence.—The correspondence of the office the past year was far greater than any former one. As in former years, inquiry was made concerning most every feature of forestry, both by individuals and corporations. Most inquiry, however, was concerning forestry for fencing post, cross-tie and shade tree plantings. Three hundred and sixteen such recommendations were made from the office. Twenty-five hundred copies of the "Fifth Annual Report" were mailed from the office to individuals upon the regular office mailing list. In addition, about one thousand copies were mailed from the office upon special request by letter, and about five

hundred copies were expressed to high schools, clubs and special individuals upon request. Indications, judging from the inquiries made of the office, are that the subject of forestry is receiving the attention of the best classes of citizens throughout the different sections of the State.

Forest Inspections and Written Instructions Rendered.—The forest tracts visited and written instructions given were about the same as in former years. Eight splendid plantings and proposed forest cultivations were visited during the past summer, and written advice made to the owners as to the methods and plan of work. These eight tracts aggregate seven hundred forty-three acres.

This amount is by no means all that was done in real forest planting and cultivation. In every county in Indiana can be found plenty of forestry operations which are being conducted by the owner upon his own plans and ideas or upon information gained from reports, bulletins and other sources. The incomplete statistics taken by the State Statistical Department show that twenty-nine counties each planted more than ten thousand trees since 1901, the time of the establishment of the Forestry Department. The total number of trees planted in the State, by the statistics taken, from March, 1901, to March, 1906, is 1,297,645, of which 200,592 were planted in Washington County. A personal knowledge of many counties given in the statistical report show the inaccuracy of the data. In many of them a single individual is known to have more trees planted than is given for the entire county, and that more than double the number of trees given are known to be planted by two individuals, and it is further known that in such counties many persons are doing splendid forestry work. What is true of many of the counties named is also true of many not named and given as planting below 10,000 trees. This incompleteness bears out the request by the Board for a field assistant to go into the different counties and do systematic work, and thus ascertain the extent and manner of the forestry work now in progress, and render a report upon the same for the benefit of the public.

Conclusion.—The increased requests made of the Department for literature, and coming as it does from the best classes of people, is evidence of the successful argumentation of the subject before

the public. The increased demands for the various expenses of the office prevented the mailing of as much literature to the addresses upon the office mailing list as was desired, but the mailing of such reports as are being published by the Department, and such as should at all times be published, are expensive when mailed in large numbers. To send them in bulk and depend upon others to distribute them is not a business way, let alone the doubt of certainty that they will be properly delivered into the hands desired for them. The office, by means of the presidents of the farmers' institutes throughout the State, has secured and formed a mailing list of 8,000 names of the best representative citizens, and representing every county in the State. To properly supply this list of names with literature at least every two years, and to carry on the regular correspondence that will be required as the work grows and develops, an expense for postage of at least five hundred dollars will result. The present office fund, one thousand dollars, will sufficiently meet the requirements of the office if the field work is provided for by other means. The present funds will not do both, even if the office as it is now organized could find the time to do the necessary field investigation and advise. The Board requests that it be given at least the sum of twelve hundred dollars to employ competent field help for at least eight months in the year to do systematic county work and report upon the same. Closer organized work among the people is needed, and, as stated before, this small addition will make the Department so much more effective. This one feature of additional employment and expense is all the Board suggests.

Report of Work Accomplished.

AT THE STATE FOREST RESERVATION AND EXPERIMENTAL STATION, HENRYVILLE, CLARK COUNTY, INDIANA, TO DECEMBER 1, 1905.

Improvements.—The various features of improvements began and not fully completed at the close of last year were advanced to completion, or as nearly so as could be done with the means at command, the past summer.

The roads planned from the headquarters buildings across the Reservation to connect with the public highways which extend along the southern and eastern boundaries were completed in outline and grading this last spring. They will be gone over and regraded this fall, and the proper drainage crossings constructed. It then remains to place gravel upon them to have complete driveways, and there is plenty of such material upon the Reservation. This last feature of the road-making should by all means be accomplished in the near future. Not much work, as hauling and marketing the product, can be performed during the winter months in this section of the country owing to the impassableness of ordinary roadways under slight rainy stimulus. The field cultivation work of the summer requires that the hauling be done at other seasons of the year, consequently the need of getting the roadways in good order at an early date.

The reservoir building was advanced but little the past summer. The funds needed for this work proved to be more than was asked and appropriated by the last General Assembly. Consequently, with the exhaustion of the appropriation, the work was abandoned. As stated in last year's report, that soon after this work was begun, and before completion, heavy rainfall came, and the same has been plentiful to the present time, and there has arisen no necessity for further efforts, but to anticipate future needs the reservoirs, as planned, will be completed. The esthetic influences to the Reservation will justify their completion.

The building improvements which were planned were also not advanced any during the past year. The new administration buildings planned at the northeast part of the Reservation, and

as shown in the map of last year's report, remain uncompleted. At the time of asking for and receiving the appropriation for this improvement, the Board intended the sum asked as a help to be applied in conjunction and correlation of work with the regular and other appropriations to complete the buildings, and not as a sufficient amount for the full accomplishment. It was later ascertained by a decision from the State's Attorney-General that where a specific appropriation was made that the general appro-

View of a forest cleaning now in progress at the Forest Reservation.

priations and others could not be applied in conjunction, even if they naturally correlated. Consequently, the building was advanced toward completion as far as the means appropriated would go, and left for final completion at a future date. The convening Assembly will be asked for a sufficient sum to complete these buildings. The further building improvements, as planned at the northwest and south central parts of the Reservation, will not be attempted, because the appropriations asked for and granted by the last General Assembly were based upon the same intentions, and consequently will not be sufficient. The sums for such

improvements, four hundred fifty dollars ($450) and five hundred fifty dollars ($550), respectively, and made available November 1, 1906, will be allowed to revert to the State unexpended. (These features will be more fully discussed under recommendations at the close of this chapter.)

The forest cultivation was progressed to the fullest extent

View of the forest lands at the Reservation after being treated to the forest cultivation and the product all removed.

throughout the year, with the exceptions of the time from April first to August first, which time is not considered a good season to cultivate forests by trimming and cutting out, because of the fact that sprouting occurs so numerously from stumps of trees cut during active sap flow, and the same is true of cuttings made by pruning the trees. Also, timber cut during such a season sours and rots under the bark, and worms attack and destroy the wood

so vastly, much more than when the trees are cut or pruned during dormant sap or during the time from August first to April first. Beginning at this latter time (August first) the forest cultivation was constantly kept under progress. During the past year about two hundred twenty-five (225) acres have been thoroughly cultivated, and most of the product sold, and the money remitted to the State Treasurer upon the recommendation of the State Auditor. The cultivation performed the past year was of the same

A view of a specimen of the trees removed from the forests at the Reservation in applying the forest cultivation.

character as of former ones. All the trees of every kind that are so damaged by fires or other causes of past years that no future value would accrue from them are taken out; all worthless commercial species are also removed, as well as all excess trees over and above the number thought to be all the land will properly mature. The aim is to leave upon the land to grow and mature an average of two hundred (200) standard trees per acre of from three to fifteen inches in diameter. The greater part of the cultivated forest contains more than three hundred (300) trees

per acre, and but few acres contain less than 100 trees. In some places fires of former years damaged the standing trees to such an extent that the cutting out is extensive. In all such instances the vacancies will be transplanted with seedlings of standard species this fall and winter. The trees cut out are converted into whatever product they will best make, and sell for the best price. The statement of sales and receipts of products from the Reservation in the "financial report" will show the forms of material obtained from the forest cleaning. The two cuts accompanying will show the character of the forest after it has been cultivated.

The income derived from the sales of product as by the "financial statement," does not indicate the entire product obtained for the year, but simply the amount sold to October 31. There remains a minimum invoice amount of wood, cross-ties and lumber yet on hands to be sold to the value of $361.25. It is intended that final sales of the product for the fiscal year ending October 31 will result in about $2,100. At the time the appropriation was asked for this forest cultivation work, the wages for labor per day were estimated at $1.25 and $1.50, but owing to the construction of the Indianapolis and Louisville Traction Line through the vicinity, and which extends along the eastern border of the Reservation, the price of labor advanced to $1.75 and $2 per day, thus lessening the amount of labor which it was intended to secure for the money appropriated. Also, no market existed at hand for such class of product as was obtained, and sales depended on such demands as could be originated. Much of the material was sold at a low figure, with the aim in mind of building a market. Such has now been accomplished. A good local market in the town of Henryville for wood and rough building lumber has been established at reasonable figures for the class of material. A cross-tie market for the mixed oaks was also originated, as no market existed for such class of railroad ties in the region of the Reservation. The Traction Company were prevailed upon to use mixed oak cross-ties, and thus a market at hand was secured. A market has also been secured with steam roads elsewhere, and cross-ties will be shipped to points remote from Henryville. A splendid fuel market has been established at Chicago, Illinois, and 100 carloads of fuel have been sold at a good figure f. o. b. Henryville, and a

bond securing the transaction has been filed with the Board by the purchasers. At the present established market prices and labor a good standard acre of woodland was taken, and the following tabulated results obtained from cultivation, and by it the future outcome of the work may reasonably be anticipated:

Product and Sales—	
61 first grade mixed oak cross-ties at $0.30	$18 30
21 second grade mixed oak cross-ties at $0.20	4 20
8¾ cords mixed four-foot wood at $1.75	15 31
400 feet mixed lumber, per hundred $1.20	4 80
Total	$42 61
Labor Expenses—	
Making 61 first grade mixed oak cross-ties at $0.12	$7 32
Making 21 second grade mixed oak cross-ties at $0.08	1 68
Hauling 82 mixed oak cross-ties at $0.06	4 92
Cutting 8¾ cords mixed four-foot wood at $1.00	8 75
Hauling 8¾ cords mixed four-foot wood at $0.75	6 56
Cutting logs, 400 feet per thousand, at $1.25	50
Hauling logs, 400 feet per thousand, at $5.00	2 00
Sawing lumber, 400 feet per thousand, at $4.00	1 60
General overseership, approximated	2 00
Total	$35 33

Net proceeds per acre, $7.28.

The standard trees retained on the ground after being treated to the above cultivation were as follows:

White oak	171—average size 8 inches.
Black oak	104—average size 6 inches.
Hickory	186—average size 4 inches.
Chestnut oak	8—average size 6 inches.
Maple	12—average size 4 inches.
American chestnut	1—size 2 inches.
Black gum	3—average size 5 inches.
Total	485 trees.

The above items of sales and labor expenses are so conservative that future results may be assured as good. The item of fuel, however, will be better than above stated, since the contract now secured for the present year is almost, if not, fifty per cent. better than former prices obtained. It is not thought that much better figures can be secured for the lumber and cross-ties, because of the character of the product taken. No good trees are cut, and, consequently, to say the best, the material is inferior and must sell as such. Good material can be sold at good prices anywhere and by anybody, but not so with bad stuff.

The Board attempted at the beginning of the forest cultivation to secure all labor by piece contract, but after trial such will be abandoned. Under it proper attention to the matter of tree selection and stump cutting, care of timber, care of standing trees, completeness of cultivation details and general neatness and character of workmanship on the product could not be secured. Under it the amount earned per day by the employes was given more emphasis than the forestry interests. The present plan is that of employing none but the best men, energetic and honest, put them in charge of a good foreman who demands strict compliance to rules and instructions. Under this plan the forestry interests are emphasized and the financial returns are equally as good. Good men under the existing labor conditions can secure all the employment they want at a good stated salary per day, and therefore will not submit to piece contract. Men who are not regularly employed and will submit to piece contract work are not the most responsible, and thus not desired in particular scientific work. After thorough trial the former plan of employing none but the best men at a good salary per diem, to work under the direction and instructions of a competent foreman, will be followed.

The test acre itemized above must not be construed to mean an average for the woodland which is under cultivation. It is more than an average. But by it can be safely estimated the results for the future of the work in forest cleaning. The worst will fully pay all expenses of accomplishment and the better parts will return to the State a good sum in advance of the cost of doing the work.

The General Assembly will be asked by the Board to continue the specific appropriations for forest cultivation as now given. The sum asked of the last General Assembly did not cover the amount sought to be cultivated, but it returned an equal amount to the State from less than half the area intended to cultivate, which is even a better showing for the institution. A continuation of the appropriation upon the same principle, returning to the State Treasury an amount equal to that expended, for all money appropriated for forest cultivation and a good per cent. in addition. The prime forest retained upon the ground will surely pay all the State's additional invesement within a quarter of a century at the farthest. Not an unfavorable comment has ever been ex-

pressed by persons familiar with commercial forestry upon the project. It is regarded by all such individuals as a splendid commercial invesement and one of the best object lessons for which it stands—practical forestry upon the cheap lands of Indiana.

The seed planting which was in progress last fall was continued this last spring as soon as the ground would permit. In addition to the 71 acres planted, as per last year's report to December 1, five acres of walnut were planted, 200 pounds of Speciosa Catalpa seeds and 200 pounds of black locust seeds were sown in nursery, and eight bushels of acorns were also sown in nursery. The area occupied in this is about 18 acres. These seeds grew well. A larger per cent. of them germinated than in any former plantings, because the moisture conditions were splendid. On this latter planted area and also upon most of the area planted last fall, oats were sown this spring and permitted to mature and were harvested. The experiment may be regarded as a good thing to do in such instances where all the needed cultivation can not be given the young seedlings. In most instances of forest seed planting growth does not take place soon enough for sufficient cultivation to be given to keep down the rank weed growth the first season, and consequently many trees perish. This overcrop does not seemingly have any damaging effects upon the young trees, as they grow well under the oats crop and the weeds do not thus overcome them. The experience of this past season is such as to commend it. The plan is largely in vogue in countries of long forestry experience. The seedlings may not make as large a growth as they would if the overcrop were not grown and all the needed attention in cultivation were given the seedlings from the very start, but such can not be done on as large a scale of planting as is done at the Reservation and with the funds provided for the work. The trees, however, with the overcrop, get such a start that the following season, with reasonable cultivation, they will make splendid progress, and thus so much less expense is incurred in their propagation. Such areas as were not given to this overcrop were given two good cultivations, and results are satisfactory.

The planting contemplated this fall and which is now in progress is as follows:

Eight acres, clay upland, 620 feet elevation, white oak and hickory.

Seven acres, bottom land, 600 feet elevation, red oak, burr oak and large shellbark hickory.

Five acres, upland clay, 700 feet elevation, American chestnut.

Three acres, upland porous clay, 700 feet elevation, black walnut and American chestnut.

Three acres, upland clay, 570 feet elevation, American chestnut.

Five acres, upland clay, 620 feet elevation, mixed oaks and hickory.

In addition to this regular planting, all the fields planted in former years will be gone over and the vacancies planted with either seeds or seedlings, as is desired. This work has not progressed far enough to give the exact extent in this report, but will be continued throughout the fall, winter and spring until completed. To accomplish this work and to plant a larger nursery the following list of seeds and seedlings have been ordered and are now arriving at Henryville:

Fifteen bushels American chestnuts.
Eight hundred pounds American ash seeds.
One hundred bushels black walnut.
Five hundred pounds yellow poplar seeds.
Five sacks sweet gum balls.
Ten bushels shellbark hickory nuts.
Ten bushels white oak acorns.
Ten bushels red oak acorns.
Ten bushels burr oak acorns.
Fifty pounds American linden seeds.
Twenty pounds standard white pine seeds.
Twenty thousand American ash seedlings.
Twenty thousand American elm seedlings.
Ten thousand yellow poplar seedlings.

It is not expected that all of this stock will be secured, but most of it will and is now in transit, and with it the planting intended at the Reservation will be largely accomplished. The nurseries will also be extensively planted from the supply.

Tree transplanting was also done to the extent of the surplus supply of seedlings obtained from the excess seedlings grown in the fields from the regular plantings of former years. At the time of planting the seeds two or more seeds were placed in a hill. In

places where all came the excess seedlings were taken out and transplanted where vacancies occurred. About 450 walnut seedlings one and two years old were transplanted. Contrary to facts gleaned from reports on walnut transplanting, scarcely a loss occurred. It must be acknowledged, however, that the growing conditions the past spring were more than good. Also there were about 1,500 chestnut and 2,000 black locust seedlings secured in the same manner and transplanted with equally good success to vacancies in the regularly planted fields. This fall there were taken from the nursery 6,700 American ash seedlings, 1,000 black locust seedlings, about 1,800 Kentucky coffee-tree seedlings, 800 American chestnut seedlings, 200 Texas pecan seedlings and about 2,000 mixed oak seedlings. These seedlings were transplanted to vacancies in the fields. On all the nursery site of eight acres a regular stand of trees was retained at distances of four and five feet apart.

With the accomplishment of the plantings intended this fiscal year the aims of former years will be attained. The fields were planted with seeds of trees which are difficult to transplant, with the view that a fairly good stand of such trees as the oaks and hickories would be secured on the fields. This was then to be followed with seedling transplantings, wherever vacancies occurred, with a mixture of different species to obtain the desired mixed hardwood stand of forest for future growth. It is a pleasure to look upon the completion of this aim and purpose which was formulated at the beginning of the institution. This feature of the forestry plan will be carried forward constantly during the fall, winter and spring. Throughout the cultivated woodland the patches where the stand of trees is not sufficient will be transplanted with seedlings in the mixture desired. Also upon the bald slopes of the Knobs, where the forest fires in past years have almost completely destroyed the forest growth, the seedlings will be planted. An attempt was made to regenerate these areas by planting seeds upon them, but it only proved to be a feast for the rodents and no success came of it. It is hoped to be successful with seedlings.

The experiments being conducted in natural reforestation are most satisfactory indeed. During the fall of 1901 forest fires raged over a large portion of the area now included within the

Reservation. During the winter of 1903 parts of the burned-over area were completely cleared off, since all the trees were dead. The leaves were all burned from the ground, but the humus conditions remained perfect for growth. With the opening of the spring weather seedlings grew up thickly over the area, because the fire's burning over it had left the soil penetrable by the sun's heat and light. The growth at this time is from 8 to 12 feet in height and is made up of the oaks, hickory, maple, aspen, chestnut

A sample of the second growth jungles at the Reservation to be given cultivation treatment the coming year.

and yellow poplar. The extensive growth of the three summers is really beyond a liberal belief even to those familiar with forestry growth. Another experiment of note is that of a small field which was cleared off and planted to corn in the spring of 1900. After the acquisition of the land by the State the field was no longer tilled, and it consequently grew up with trees. The entire area is densely covered with a growth of hardwoods, most of which are oaks and hickory, though maples and aspens are plentiful. During the fall of 1904 the area was cultivated by cutting the excess and worthless kinds. At this time the trees are from 12 to 16 feet high. Cornstalks are still to be found standing among the trees.

as evidence to show the recentness of its having been cultivated in corn. The two cuts here given were taken from photographs of these two experiments. Many others similar in result could be given.

A large number of ornamental, nursery grown, transplanted trees were secured and planted along the roadways of the Reser-

View of natural reforestation on a field which was cleared and planted to corn in the year 1900, but since permitted to grow up in trees and cultivated.

vations. Two hundred and fifty American elm, 250 American ash, 250 American linden and 250 maples, of from 8 to 10 feet in height, were planted at distances of 25 feet apart on both sides of the roads in the open fields. This work adds very greatly to the appearance and will also be an object lesson in ornamental tree planting. Other species of trees will be planted in coming years, so

that all forms of ornamental trees for street and lawn planting can be observed growing, and thus the best kinds determined by example. Methods of pruning will also be practiced to obtain results.

The cultivation given the young trees growing in the regularly planted fields was of two forms, plowing in the same manner that corn is cultivated and by hoeing. In some fields the trees were plowed and hoed, while in others they were simply hoed without plowing. They were given two complete cultivations. One plan

A view of a natural forest growth upon a tract of woodland cleared off in 1901, after being burned over by fire.

seems as successful as the other. The aim sought by the cultivation was to keep down weed and other wild forms of growth that might overcome the young trees. In the fields where the soil around the young trees was kept loose and free from weeds for a short distance from the trees (8 to 12 inches) by hoeing, and the other forms of growth permitted to stand around them, the young trees seemed to do the best. The only reasonable opinion that can be given for this fact is that the other growth formed a mulch over the soil and prevented evaporation and also a forest condition of shade and protection which resulted in good to the trees and by

keeping a clear opening around them prevented them from any smothering out, as will occur where the weeds and other growths are permitted to grow up close around them. The young trees in such fields are larger and have better boles formed than those growing in the fields where more complete cultivation was performed. Those growing in the more open fields and where the most complete cultivation as to keeping the soil cleaned of all forms of outside growth seemed to grow more bushy and to cease growing earlier in the summer than the others. The only reasonable opinion to be given for this fact is that they were more exposed to the heat of the sun, nothing formed a covering to the soil to prevent evaporation, and the trees were deprived of any form of shade protection. No forest influence was thrown around them. The two accompanying cuts show an ash and walnut seedling grown in the fields. The ash is two years growth from the seed and the walnut three years growth from the seed. These show the manner of growth obtained by close planting. It has been feared by those interested in the project that trees grown in the open fields from seed would be low and bushy. Such is not the case. In each of these plantings there are about 6,000 trees and the bole forms of all of them are splendid. These plantings are four and five feet apart and in perfect rows.

It must not be inferred from the discussion of the cultivation here given that no cultivation is needed. The young trees must be given the cultivation necessary to protect them from weed and other wild forms of growth immediately around them, but it is not thought that they require the extensive and complete cultivation that an agricultural crop demands for its successful growth. The trees at the Reservation are only given the cultivation that can be performed with the means supplied, and no more. If more means were provided they would be cultivated more and better results might accrue, but the results are satisfactory with the aims, simple, practical forestry upon the cheap lands.

The outlook for the future of the Reservation seems good. The institution is a great influence in promoting the entire interests of the community surrounding it, and in a general way almost all of southern Indiana is being materially benefited by it. It has the respect of all good thinking citizens and its influence as a factor of education in forestry is very apparent. The Board trusts that its

modest requests before the coming General Assembly will meet with the kindest approval. It keenly realizes that the public must rely largely upon its statements for the facts concerning the institution, as not all can personally investigate for themselves. Instead of its being a matter of seeing and believing it becomes one

View of a black walnut three years old, from the seed in a plantation of 6,000 trees at the Forest Reservation.

of hearing and forming conclusions therefrom. The Board is using its best efforts in the management and experiments to ascertain the best methods and plans for simple, practical forestry for the masses, as against the overenthusiastic, scientific ideas which would at once place it upon the pinnacle of scientific technique and

wait for the masses to ascend thereto. It is the belief that the science of forestry in all its grandeur can not precede but must and will naturally develop as the spirit of forestry is formed, and when such spirit fully exists then it will be appreciated.

The one thing most sought by the Board is the demonstration of growing the known valuable commercial forest trees natural to

View of an American Ash seedling two years old, from the seed in a plantation of 6,000 trees, at the State Forest Reservation.

Indiana. Too much is the belief that they can not be grown to commercial sizes within a lifetime, and consequently experimental trees are being mostly planted. The Board appeals for the united support and encouragement in the cause of forestry and the Forest Reservation and Forestry Experimental Station by the citizens of Indiana.

The Farm Woodlot.

The farm forest tract is now rapidly disappearing. The rapid growth of agriculture and the advanced prices offered for all forms and species of timber has induced farm owners to rid their farms of timber, until now it becomes imperative that systematic farm forests shall be instituted, and that the same shall be inaugurated is one of the chief aims of this Department. Farm forests are most valuable to the material development of the country. They will supply the timber needed for all local uses, and to a considerable extent supply the commercial demand for manufacturing needs. They will also greatly modify climatic extremes, purify the atmosphere, and add beauty to the landscape. Further it is a thing in which all will be benefited, and in which all should join in promotion.

It is to the end that farm forests under systematic conduction will be instituted throughout the limits of Indiana that this bulletin is issued, and the suggestions herein are for the purpose of stimulating and guiding any who may seek to engage in the work, and the plans and methods are aimed to be stripped of all technical, graduated features, and of such character that any farmer with his own labor and means at hand can accomplish his own forestry work. It is not the thought that scientific methods shall be discouraged, but that it is better to have common everyday forestry first and then grow into the science. It is the thought that the farmer who plants a bushel of forest seeds and plows and hoes them after they are growing, or keeps stock from grazing in his reserved woodland, and prevents fire from burning through it, will produce more timber than if he were to attempt to follow the voluminous theories concerning scientific sylviculture.

To the fullest extent possible, this Department will render assistance in all details for the farmer's forest tract, and it appeals to the landowners to give the subject their candid thought and active observance. It is the aim to have a special field assistant for the Department, whose duty it shall be to visit and counsel with all who seek help in their work.

REASONS FOR FARM FORESTS.

There exists in the minds of many that forestry is simply a fad; that it originated in the minds of individuals who loved trees as such; in other language, it was the origin of a tree crank and fanatic. Such an idea is most erroneous indeed. It may be that such persons are in existence, and that they are advocating forestry, and if so give them credit for that good feature, but not for the origin of forestry as an institution of governments. Forestry has for its origin the best thought and intellect, and for its foundation the most vital elements of welfare. It is the origin of minds capable of seeing far into the future and perceiving conditions in advance, and is based upon the elements of industrial good, climatic modifications, and for the embellishment of the landscape in all the features of ornament, drainage, erosion and fertility of soil.

THE FUTURE FOREST SUPPLY.

The future timber supply is a matter that is at this time puzzling many a wise man. The manufacturing concerns now within the State, which, because of the past abundant timber supply, have prospered and grown to be large industries, are now facing the problem of timber scarcity in a most embarrassing form. The railroad corporations are now compelled to resort to almost any device in order to find timber to supply their needs of cross-ties and construction. A moment's intelligent thinking can but clearly reveal the stringent timber condition in Indiana, and what is true of our own State is largely the situation elsewhere, except in a few remote localities where only recently civilization has spread, and in such instances the timber is being cut and used with such rapidity that a few years more will see it devastated to the same degree as in other civilized sections. The different experiments in fuel as peat, denaturalized alcohol, crude oil, and the many other devices as oils and gases for fuel, are not all the outgrowth of attempts for the sake of convenience, but, on the contrary, are the results of timber stringency for fuel.

The idea is frequently advanced that when all the timber is gone there will be substitutions that will answer the purposes. Also, there are those who say that there will be plenty of timber

to last as long as they live, and after that they do not care. In attempting a reply to these arguments there can be but the following truthful answer: It will be found impossible to substitute in the majority of uses. There is a quality about wood indispensable for use. Wood has been, and always will be, equal in demand and use to any other material, and as long as there is industry there will be a demand for wood. Because, then, that wood is indispensable, and also because it can not be manufactured, but must grow, and, further, because the present supply is becoming rapidly exhausted, the future supply can only be hoped for through and by engaging in forestry. Putting to the most wise use the present supply and growing new forests is the only and absolute way to have timber for the future. As to the individual who reasons only for his own lifetime, the sooner he gets off the earth the better for the community in which he lives.

CLIMATIC BENEFITS.

That a well arranged system of farm forests will be of great benefit to every community within the State in the matter of climatic modulation should appeal to every citizen. It is an erroneous idea to advocate that forests will within themselves be the means of producing rainfall or snow. It can only be contended for them that they may in a way accelerate the precipitation of moisture from the atmosphere. Forests are an aid in preserving the climatic equilibrium by means of preventing rapid evaporation, directing the water into and retaining it in the soil, forming a check to winds, and by influencing in the same manner as bodies of water in tempering the atmosphere as it comes in contact by passing over or through them.

EVAPORATION.

Forests, by means of their foliage, break the sun's rays from the soil, either completely or in part, and thus limit evaporation. Experiments have proven that the per cent. of evaporation is least under a forest cover and is greatest in open fields, and that a gradual increase occurs as the distance from the woods out into the open field becomes greater.

A few tests made for the purpose of determining the influence

of forest or other cover upon evaporation are here given. An experiment made in Germany in 1883 during the months of July and August resulted as follows: From 1,000 square centimeters of bare ground 5,730 grains of water were evaporated, and from the same area, and at the same time, of similar open ground, but covered with straw to a depth of two inches, only 575 grains were evaporated.

The following is a report of experiments made by F. H. King, University of Wisconsin, and in which can be found much good data along the lines of forest influence upon evaporation and general climate. The entire report is here given:

INFLUENCE OF TREE PLANTING UPON THE DUTY OF WATER IN IRRIGATION.

In the effort to discover and establish underlying principles of agricultural science and to direct agricultural practice along lines which shall be in harmony with them, thus leading more directly and certainly to higher economic returns, we stand greatly in need of an increasing body of accurately determined fundamental facts; and it is very much to be hoped that it will be more and more recognized that the development of these fields falls properly within the purpose of Government aid and work. An adequate discussion of the broad problem of how to secure the maximum duty of water in agriculture is not at present possible on account of lack of a sufficient body of well established facts; and this is especially true of that phase of the problem relating to the influence of tree planting upon the duty of water. The body of accurately determined facts regarding the influence of windbreaks of any type upon the wind movement close to the surface, and especially upon the rate of evaporation from foliage, soil, and water surfaces, is extremely small, and yet such knowledge is necessary to a proper treatment of the subject. Some general facts and tendencies have ben ascertained which are helpful for a preliminary consideration of this subject.

INFLUENCE OF WINDBREAKS UPON VEGETATION.

There is no doubt but that under certain critical conditions windbreaks do exert a very measurable influence upon vegetation. In the spring of 1894 (Bulletin 42, Wis. Agri. Exp. Stations) during May and June, an opportunity was afforded to make a somewhat critical study of this subject under field conditions. There is in Wisconsin an area of some ten thousand square miles of light sandy soil or sandy loam, and upon the lighter and more sandy portions of these soils crops are occasionally very seriously damaged by the drying effect of the wind; and the fertility of the soil is much reduced by the drifting which occurs at such times. At the time in question there had been a heavy fall of rain on the 5th and 6th of May, but on the 7th it was clear and cold with a strong wind

blowing from the northwest. During this and the following days, notwithstanding the rain, the soils on many fields about Plainfield and Almond, Wis., had been badly drifted. On the morning of the 8th the drifting had gone so far, on many fields, that at both places the loose sand with which oats had been covered, whether with seeder or with drill, had been driven from the fields to such an extent as to leave the kernels entirely exposed and the plants lying flat upon the ground hanging by the roots and whipping in the wind. On the fields where the

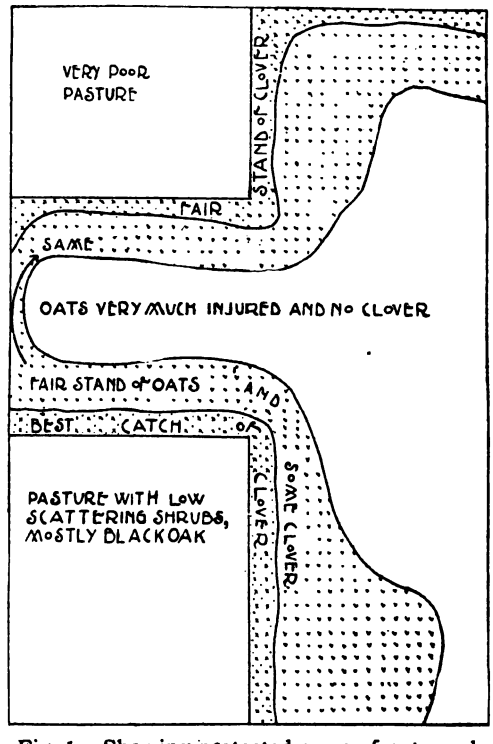
VERY POOR PASTURE
STAND OF CLOVER
FAIR
SAME
OATS VERY MUCH INJURED AND NO CLOVER
FAIR STAND OF OATS AND BEST CATCH OF CLOVER
PASTURE WITH LOW SCATTERING SHRUBS, MOSTLY BLACK OAK
SOME CLOVER

Fig. 1. Showing protected areas of oats and clover in the lee of woods and pasture.

whipping had not been so severe and where oats stood three inches high, the oats had been cured like hay close to the ground, and even the leaves of dock sorrel were blackened and so dry as to crumble in the hand. Very many of the blades of oats, through wilting, had broken over close to the ground, presenting an appearance which suggested to the farmers that they had been cut by hand. It was at once evident, to the most casual observer of the fields at this time, that wherever a field lay to the leeward of any sort of shelter the destructive effects of the wind were either not apparent or else they had not been nearly so severe.

About three weeks after the first serious injuries had occurred a careful study was made of many fields and the results are recorded in detail in

the bulletin to which reference has been made. Some of the observations made at this time are cited here in illustration of the decisive evidence regarding the influence of windbreaks upon vegetaton. A north and south road two rods wide fenced with wire, along which are scattering trees 10 to 18 feet high, together with a scanty growth of hazel, had a field of oats lying to the east which was greatly damaged; but a strip two rods wide, next to the road, appeared wholly uninjured. A field of oats lying to the east of a field of timothy, in which there was a strong growth of dock sorrel, had a strip of oats 200 feet wide next to the grass where the stand was good, while on the eastern half, thirty rods wide, the plants were entirely destroyed. Another oat field having grass on the north and west sides, and bordered by a rail fence, showed a strip of uninjured grain 100 feet wide next to the two fences and fully 200 feet

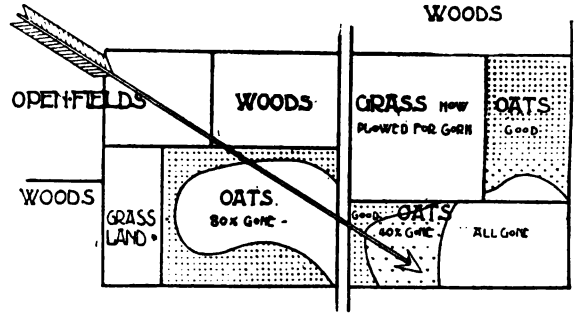

Fig. 2. Showing three fields and surroundings where oats had been entirely killed, together with areas protected from the wind.

wide in the northwest corner of the field in the lee of the two fences. In another oat field fully five-eighths of it had been so thoroughly destroyed by the wind that it was harrowed and fitted for potatoes, but a strip along the rail fence on the south side, 150 feet wide, had been allowed to remain on account of the better stand, and on this area, as was usual generally, the number of plants increased as the fence was approached. To the west of this same field there was another of timothy, and adjacent to this there was a strip of oats 200 feet wide where the stand of plants was markedly better than farther away; and the same fact was observed in an adjacent field lying to the east of a closely fed pasture free from trees and shrubs. In another field 120 rods long from north to south and 80 rods wide, seeded to oats and clover, the effect of the surroundings upon the crops is indicated in Fig. 1, where it will be seen that at a certain distance from the conditions which have influenced the temperature, humidity, and velocity of the wind, the oats had been very much injured and the clover had been entirely killed out.

In Figs. 2 and 3 the condition of crops which were observed on other fields, and the surroundings which produced these differences, are also shown.

In Fig. 2 the southeastern field is 80 rods long and 30 rods wide. Here it will be seen the oats were good along the road in the lee of the two

fences, 40 per cent. gone further away, and entirely destroyed on the eastern half. Further north the field of oats adjacent to the field of grass and with woods to the north and in the distance to the west, had a good stand of plants, being seriously injured only at the south, where the wind came through between the two pieces of woods along the course indicated by the arrow. Similarly, in Fig. 3, the influence of shelters is clearly and sharply brought about by the condition of the crops observed and there recorded. The southern field in this figure was 60 rods from east to west and 30 rods wide. It will be seen that the half of the field stretching out into the path of the free wind coming through the gap between the two pieces of woods, as indicated by the arrow, has lost all of the crop, while the stand increased toward the woods on the west and was good at a distance of 10 to 20 rods from them.

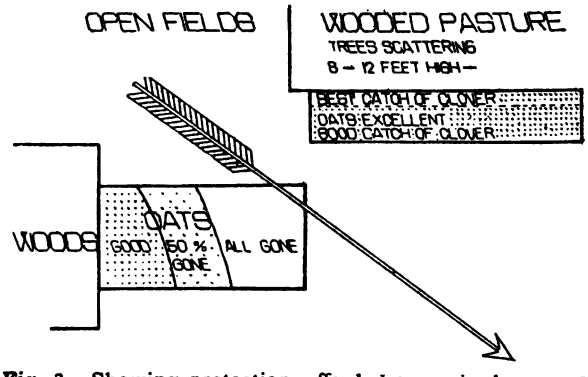

Fig. 3. Showing protection afforded to grain by woods and direction of destructive winds.

The piece of oats lying on the south side of the scantily wooded pasture was in excellent condition, and although only 15 rods wide, a very appreciable difference could be seen in the stand of clover, to which the field had been seeded, on the margin most distant from the pasture. Even fields of corn stubble having fields of oats to their leeward were observed, in three instances, to have exerted very marked effects upon the stand of grain, and in one of these fields, on one portion of the protecting corn stubble, there was a strong growth of dock sorrel. To the leeward of this part of the field the oats had been much less injured, suggesting that the effect of the humidity of the air passing across this may have been enough altered to render the wind current appreciably less destructive. Observations like these appear to place beyond doubt that, under certain conditions, at least, windbreaks do exert a very measurable effect upon the vegetation of cultivated fields.

On three other oat fields which had been seeded to clover and which were bordered on the west with fields of grass, the number of clover plants upon unit areas which had survived the effect of the wind was determined at different distances from and to the leeward of the fields of grass. The counts were made in series along east and west lines at right angles to the margins of the grass fields, and the results are given in the following table;

TABLE

Showing the Decrease in the Number of Young Clover Plants Per Unit Area With Increase of Distance to the Leeward of the Margin of Grass Land.

Distance from margin of grass. Feet.	No. of Plants. Series 1.	No. of Plants. Series 2.	No. of Plants. Series 3.	No. of Plants. Total.
		Field No. 1.		
50	187	209	187	574
200	120	139	131	390
400	88	75	68	231
		Field No. 2.		
100	77	73	99	249
200	55	109	113	277
400	43	78	72	193
600	67	66	56	189
800	54	54	30	138
1000	27	11	10	48
		Field No. 3.		
50	377	382	371	1130
400	166	209	225	600
700	203	180	160	543

These three sets of data appear to leave little room to doubt that, in some manner, the grass fields to the windward of the fields seeded to clover did exert an influence which materially affected the stand of clover on them. In what manner this effect may have resulted will be referred to later.

INFLUENCE OF WOODS UPON THE RATE OF EVAPORATION TO THE LEEWARD.

At the time of the observations just described others were made to measure the rate of evaporation at different distances to the leeward of woods, using a form of Piche evaporometer rendered more sensitive by increasing the diameter of the evaporating surface to 5.9 inches, thus giving an effective area of 27.06 square inches, deducting the area of the water reservoir, the latter being regulated to .1 c. c. The instrument as placed in the field is represented in Fig. 4.

Fig. 4.—Showing the form of Piche evaporometer as placed in the field.

With a series of six of these instruments set up in a line at right angles to the margin of a black oak grove having a mean height of 12 to 15 feet, the rate of evaporation which occurred simultaneously between 11:30 and 12:30 a. m. was measured, with the results given in the next table.

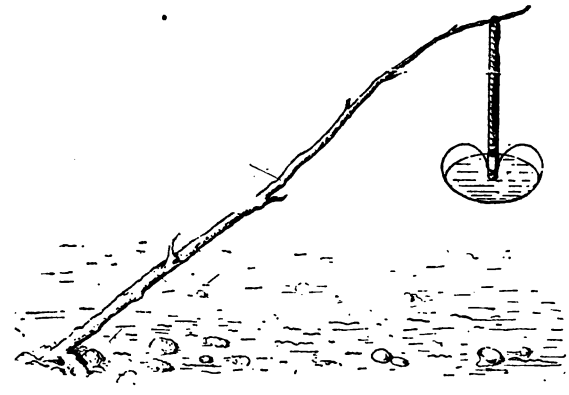

Fig. 4. Showing the form of Piche evaporometer, as placed in the field.

TABLE.

Evaporation One Foot Above the Surface at Different Distances to the Leeward of a Grove of Black Oak in a Field of Sandy Soil Recently Planted to Corn.

Distance from Woods—Feet.	Evaporation in One Hour—C. C.
20	11.0
40	11.1
60	11.3
80	11.2
100	11.9
120	12.9

These results show that until a distance greater than 100 feet is reached but little difference in the rate of evaporation was found. At 120 feet the evaporation was 17 per cent. greater than at 20 feet. Three of the instruments were next set up at 20, 40 and 60 feet, and at 280, 300 and 320 feet from the same grove and in the same field. During one hour the amounts of evaporation were as given in the next table.

TABLE.

Evaporation at One Foot Above the Surface at 20, 40, 60, and at 280, 300, and 320 Feet to the Leeward of a Black Oak Grove in a field of Sandy Soil Recently Planted to Corn.

Distance from Woods. Feet.	Evaporation in One Hour. C. C.	Distance from Woods. Feet.	Evaporation in One Hour. C. C.
20	11.5	280	14.5
40	11.6	300	14.2
60	11.9	320	14.7
—	—	—	—
Avrg. 40	11.66	300	14.4

From this table it is seen that the rate of evaporation was 23.4 per cent. greater at 300 feet than at 40 feet, basing the computation upon the averages.

In another locality the evaporometers were set up at distances ranging from 20 to 500 feet to the leeward of a piece of black oak woods where they had an average height ranging between 15 and 25 feet and were thicker on the ground. The results secured during an hour of sunshine in the middle of the day are given in the table which follows:

TABLE.

Evaporation One Foot Above the Surface of Ground in a Field of Oats at Different Distances to the Leeward of a Black Oak Grove of Trees 15 to 25 Feet High.

Distance from Woods—Feet.	Evaporation in One Hour—C. C.
20	11.1
100	14.3
200	15.7
300	18.5
500	18.3

In this series the evaporation appears to have become constant at about 300 feet from the woods and was some 66 per cent. greater than at 20 feet distant.

The effect of a scanty hedgerow was also measured. This was composed of a strip of blue grass 16 feet wide in which there were scattered black and burr oak from 6 to 8, and occasionally 12, feet high. The hedge had open gaps in it and the nearest evaporometer was set up in the lee of a clump of six trees spanning a length of 40 feet, there being a gap of nearly equal length on either side. To the windward of this hedge there was a naked field 80 rods wide recently plowed and being planted to potatoes, and the instruments hung above the field of oats where the plants were about 4 inches high. The next table gives the results obtained.

TABLE.

Evaporation One Foot Above the Surface of a Field of Oats at Different Distances to the Leeward of a Scanty Hedgerow.

Distance from Hedgerow—Feet.	Evaporation in One Hour—C. C.
20	10.3
150	12.5
300	13.4

In this case the evaporation at 300 feet from the hedgerow was 30 per cent. greater than at 20 feet, and 7.2 per cent. greater than at 150 feet, and the results make it clear that even scanty hedgerows exert a measurable influence upon the rate of evaporation at considerable distances to the leeward.

INFLUENCE OF A CLOVER FIELD UPON THE RATE OF EVAPORATION TO THE LEEWARD.

Adjacent to the naked field behind the hedgerow just considered there was a field of clover 360 feet wide along the margin of the oats and extending 780 feet back from it, across which the wind passed in its course from the north. At the same time the last observations were made a similar series was taken to the leeward of the clover, the results being those given in the following table:

TABLE.

Evaporation One Foot Above the Surface of an Oat Field at Different Distances to the Leeward of a Field of Clover.

Distance from Clover Field—Feet.	Evaporation in One Hour—C. C.
20	9.3
150	12.1
300	13.0

These results indicate that at 300 feet to the leeward of the clover the rate of evaporation exceeded that at 20 feet 39 per cent. and that at 150 feet 7.4 per cent. Comparing the evaporation from the two adjacent areas where, as stated, the evaporometers were similarly and simultaneously exposed, it is seen that the air coming across the long stretch of naked ground and then passing through the hedgerow, caused measurably more evaporation than did the current which had traversed the field of clover; and these results appear to be in complete accord with the observations cited regarding the stands of grain and clover to the leeward of woods, hedgerows, grass fields and shelters of other kinds.

INFLUENCE OF WOODS AND GRASS FIELDS UPON THE HUMIDITY OF THE AIR TO THE LEEWARD OF THEM.

At the same time that the several sets of observations were taken and at the same places, others were also made with wet and dry bulb thermometers of the Henry J. Green make, reading to tenth of a degree C. The results obtained are given in the following table, each value being a mean of 10 readings, which were made in regular rotation, passing from station to station of each series during the intervals of exposure of the evaporometers.

TABLE.

Relative Humidity of Air Three Feet Above the Surface at Different Distances to the Leeward of Woods, Hedgerows, Clover Fields and Naked Soil.

Distance to the Leeward. Feet.	Mean Dry Bulb Readings. Degree F.	Mean Wet Bulb Readings. Degree F.	Mean Relative Humidity. Per Cent.
	Grove No. 1.		
30	65.32	49.46	27.0
300	63.80	47.35	24.0
	Grove No. 2.		
20	75.04	58.35	34.6
100	73.13	56.39	33.0
200	72.03	55.83	34.2
300	71.47	55.13	32.8
400	73.63	55.63	29.6
500	73.31	55.94	30.8
	On Leeward Margin of Clover Field.		
0	52.48	43.97	48.0
	On Leeward Margin of Naked Field.		
0	53.24	43.57	44.0

These four series of observations, although too limited to serve as the basis of general conclusions, are, in a general way, quite in accord with the records of evaporation which have been cited, and also in harmony with the very pronounced observed protection afforded to oats and clover to the leeward of the various shelter conditions which have been cited. To my own mind, however, the surprise lies in finding such profound differences in crop conditions associated with the observed differences in meteorological and surface conditions. It should be borne in mind, however, in considering these relations, that the meteorological observations were not made at the time the destructive work was going on; hence what differences then existed are not known. The relations which have been observed and pointed out are clearly vital to the reclamation problems of the arid and semi-arid West, and merit full investigation, especially from the standpoint of field conditions.

The very marked influence which has been observed upon the stand of both oats and clover under the conditions cited is undoubtedly, in large measure, due to the character of the soil and to the stage of growth of the crops, the wind coming at a time when the root system of the plants was yet scantily developed and very close to the surface; but the measurable differences in the stand of clover, at such long distances from the conditions which have evidently produced them, leaves little reason to doubt that crops are sensitive to such differences of temperature, humidity, and velocity of the air near the surface as must result from the conditions whose types have been considered. There can be no doubt that rows of trees along canals and about reservoirs must very materially reduce the loss of water through evaporation from their surfaces, and such observations as have been cited make it hopeful that their influence upon the loss of moisture from adjacent fields and their effects upon crops themselves may be of much greater importance, especially in plains regions; but only fuller investigations can make certain the true relations.

WIDTH OF THE ZONE INFLUENCED BY WINDBREAKS.

Newell ("Irrigation," by F. H. Newell, page 370), in speaking of the influence of windbreaks on plains, states that: "It is estimated that every foot of height of compact trees protects a rod of ground; hence a Lombardy poplar windbreak of an average height of 60 feet, properly set out, has a beneficial influence extending practically 1,000 feet to the leeward." In the cases which have been cited the rate of evaporation and the humidity of the air were measurably affected at distances having the same or perhaps a little higher order of value; but when the effect upon the crops themselves is taken as an index, the influence clearly has a wider range, there being in the case of the fields seeded to clover so strong a contrast as 183 to 48 between the distances of 800 and 1,000 feet to the leeward of a grass field, where it appears that the influence must have been exerted in some manner other than by directly modifying either the wind velocity or the humidity of the air. It appears possible that broad continuous naked fields of dry soil or sand on clear days may have a peculiar effect upon air currents sweeping across them. The dry soil or sand itself under such conditions becomes heated and tends to expand

the air lying in contact with it, making it relatively lighter than the much cooler and more rapidly moving currents above, and it may be that when these conditions are established the warm air is displaced by the heavier, cooler, and more rapidly moving air from above. Such a current from above, aside from its higher velocity, would be likely to exert a peculiarly parching influence as its temperature rises after coming in contact with the soil. Grass covered surfaces and damp soil could not be expected to have this effect in so marked a degree, and the result may be that during windy times the air moves across damp surfaces and fields of grass in a less turbulent manner, and as a consequence maintains a higher humidity, which reduces the parching effect. If, however, the turbulency of the air currents at the surface of the ground increases their parching effect, it may be asked whether windbreaks on plains may not augment the turbulency of the currents and thus, while exerting a protecting influence over a certain distance to the leeward of them, they might not lower the duty of water in the district as a whole and have a prejudicial effect upon average crop yields. Indeed, it appears quite possible that if the windbreaks were placed too far apart such an effect might be the result, but hardly otherwise. But, even if windbreaks do exert in general a beneficial effect and tend to increase the duty of water, exact observations are yet too limited to indicate whether the magnitude of such influence would be sufficiently great to make their establishment an economic investment, much less to permit an estimate to be made of what returns might be expected from such an investment. But the problem is capable and worthy of solution.

RATE OF EVAPORATION FROM WATER SURFACES.

There is already a considerable body of data accumulated in this country which indicate the magnitude of the rate of evaporation from water surfaces. A portion of this data has been obtained by measuring the loss of water from tanks floating in reservoirs or canals, but most of them show the loss from tanks three feet square or in diameter and three feet deep, set in the ground so that the rim is within 12 inches or less of the general surface. The mean evaporation during the growing season, April 1 to October 31, as indicated by the records of 19 stations located within the rectangle 103° and 121° of longitude and 32° and 43° of latitude, is .21 inches per day, 21.149 inches per 100 days, and 47.358 inches for the 214 days in the period under consideration. The minimum evaporation at any stage indicated in the records was .14795 per day, 14.795 per 100 days, 31.66 inches for the seven months; while the maximum (not including two at Wheatland, Wyo., which appear to be exceptional) was .273 inches, 27.295 inches per 100 days, and 58.41 inches, or close to 5 feet, for the seven months, at Logan, Utah. East of the Mississippi we have access to records from but five stations in the rectangle 71° to 90° longitude and 39° 30′ and 44° 30′ latitude, and the mean evaporation has been .145 inches per day, 14.533 per 100 days, and 31.1 inches for the seven months. The records obtained at Boston, Mass., and Rochester, N. Y., are from floating tanks and the mean evaporation was at the rate of 12.09 and 11.448 inches per 100 days, respectively.

In the absence of fuller data, it is perhaps permissible to assume that the ratio of evaporation at 20 feet and 300 feet from the woods, as observed with the Piche evaporometers, is the same as would have been found from water surfaces had they been similarly placed. The mean of the three sets of observations with the evaporometers indicates that the evaporation at 300 feet was 40.73 per cent. greater than at 20 feet. If we consider the probable saving of water by windbreaks, it appears likely that, except in the cases where the trees exclude the sun from canals or reservoirs, the 40 per cent. represents the maximum saving which could be expected from windbreaks. With an evaporation of 47.358 inches, given as the mean above, the maximum probable saving would be 18.94 inches of water from a canal or reservoir.

EVAPORATION OF WATER FROM CONTINUOUSLY MOIST SOIL.

During the summer of 1903 a soil evaporometer having an evaporating surface of 11.7 square feet was maintained at each of four stations: Goldsboro, N. C.; Upper Marlboro, Md.; Lancaster, Pa., and Janesville, Wis. The soil surface was kept continuously capillarily saturated by maintaining a water level in the soil at about 12 inches below the surface, from which an autographic record was secured in each case. The mean evaporation, per 100 days, at the several stations was found to be 21.2, 15.3, and 18.0 inches at the four stations, respectively, given in the order above, or an average of 18.43 inches per 100 days, and of 39.43 inches for April 1 to October 31. If the mean evaporation from similarly moist soil surfaces in the arid regions holds the same relation to that in the humid region as is indicated by the relative rates of evaporation from water surfaces in the arid and humid regions, the total evaporation from a constantly moist soil would average 60.04 inches instead of 39.43 inches, the mean found at the four stations east of the Mississippi during the growing season, computed to 214 days. If five feet is the mean rate of evaporation from continuously moist soil in the West, the maximum saving through windbreaks would be, according to the observations cited, some 40 per cent. of the total, or 24 inches. It is, of course, never true that the surfaces of fields are maintained continuously as moist as was the case under which the rate of evaporation has been determined. It is true, however, that during the time water is being applied in irrigation and for some considerable time thereafter, the rate of evaporation will exceed that which has been recorded from the surfaces kept capillarily saturated from a water level of one foot below; and irrigators recognize the fact of rapid evaporation during the hot portion of the day through the notably less distance water will travel under a given head before sinking into the ground, than is the case at night and when it is cool.

COMBINED EVAPORATION FROM SOIL AND CROP.

At each of the places where the soil evaporometers were maintained, and at the same time, an entirely similar one filled with the same soil matured ten stalks of maize. The water level in these evaporometers, however, was maintained at 3 to 3.5 feet below the surface, instead of at one foot, and an autographic record of the evaporation was obtained.

The time between planting and harvesting averaged 120 days, and during this time the mean total evaporation amounted to 24.15 inches, or a rate of 20.13 inches per 100 days, and a total of 43.08 computed to 214 days. On these evaporometers the mean yield of dry matter per acre was 13,881 pounds, 10,000 being a large field yield. This observed mean rate of evaporation is, therefore, likely to be some higher than for ordinary field yields under the same climatic conditions, and the indications are that the evaporation from the field surface under crop may not be quite as large as has been found from the continuously wet soil surface. It may appear impossible that such a relation as this can exist, but the probability of it being true is made clearer when it is understood how great is the reduction in the rate of evaporation from soil surfaces when a thin layer at the top is allowed to become dry, and especially if it is loose and in the condition of an earth mulch. The surface of the soil in the plant evaporometers was maintained in the condition of a good earth mulch three inches deep, and the effectiveness of earth mulches is clearly brought out by the results given in the following table, where the mean amount of evaporation from firm and mulched surfaces of six soil types are given:

TABLE.

Evaporation from Six Soil Types During 28 Days With Surfaces Firm and Under Three-inch Earth Mulches, Computed to 214 Days—Seven Months.

Soil Types.	Surface Firm.	Surface Under Three-Inch Mulch.	Difference.
	Inches.	Inches.	Inches.
Sandhill	14.37	1.57	12.80
Selma Silt Loam	22.13	5.92	16.21
Pocoson	25.64	7.11	18.53
Norfolk Sandy Soil	31.87	5.89	25.98
Goldsboro Compact Sandy Loam	40.85	6.73	34.12
Norfolk Fine Sandy Loam	49.79	8.70	41.09

These observations were made at Goldsboro, N. C., in June and July, and they show that there is a very great protection against evaporation afforded by three-inch earth mulches; also, that there is a large variation in the loss of water from different soil types under like conditions through surface evaporation. As the data of this table were obtained during a comparatively dry period, and when the temperature was high, the rates and differences are perhaps as large as are likely to occur, on the average, in the irrigated districts of the West, under such conditions.

In another series of observations made under what must have been conditions closely similar to those of arid climates, columns of capillarily saturated soil 10 feet long were maintained under a continuous draught and without moistening the surface, during 314 days where the temperature ranged between 60° and 90° F. The loss of water which occurred was only determined percentagely, but from the weights of the soils per cubic foot the total evaporation, computed to 214 days, must have been very close to the amounts in the next table:

TABLE.

Evaporation from Ten Feet in Depth of Two Soil Types Under Arid Conditions Continuously During 314 Days—Amounts Computed to 214 Days.

Soil Types	Surface Firm. Inches.	Surface Under Three-inch Mulch. Inches.	Difference. Inches.
Sandy Loam	2.85	2.49	.36
Heavy Clay Loam	6.55	4.65	1.90

From these observations, and those given in the last table, it is clear that whenever the surface of a field is protected by a layer of dry soil, whether this is firm or loose, the evaporation will be relatively small; but less from the loose than from the firm surface.

It is probable that the losses of water by evaporation from fields in the irrigated districts of the western United States range all the way between 1.57 inches and 50 inches from April 1 to October 31. If this is the case, the maximum conservation of soil moisture, through windbreaks, is likely to be found to lie somewhere between 40 per cent. of 1.57 inches and of 50 inches, or between .63 inches and 20 inches for the period April 1 to October 31.

The windbreaks themselves, of course, transpire not inconsiderable amounts of water; but when they are planted about reservoirs and along canals, laterals and head ditches, they may draw largely upon water that would otherwise be lost through percolation or seepage; moreover, the land which such windbreaks would occupy is often, in part at least, necessarily waste land unless used in this manner. But if it shall be found practicable to make the windbreaks by using fruit or nut-bearing trees so that an annual income will be realized from them, even though it must be small, the promise of a good investment along this line becomes much better.

There is no disputing the fact that mulch formed in forests by means of leaves, litter, and decayed wood, retains the rainfall. The roots conduct the water into the ground, and forest areas thus become moisture reservoirs. The soil, because of the shaded condition and the moisture in it, is at all times cooler and more equal in temperature. It, to a degree, is like a body of water in that it takes on heat less quickly and gives it off more slowly. The opposite, however, is the fact in the instance of open fields. The rainfall thereon has nothing to check and hold it. It soon flows over the surface into the streams and away before any quantity of it can be absorbed into the earth. The open fields readily take on the heat from the sun during the day, and quickly yield it up during the night, and thus open lands are constant extremes of heat and cold, and consequently, by the effects, are incentives for violent storms. Further discussion can not here be given the

effect of forests upon climate, but every law of the unequal distribution of heat from the sun to the earth's surface and the consequent results upon the expansion and contraction of the atmosphere covering the earth and thus producing violent storms is closely related. Forests beyond question moderate the climate.

ESTHETIC BENEFITS.

The up-to-date farmer is as great an admirer of the truly beautiful, and is as much concerned about the looks of his farm and farm premises as is the city property owner for his house and lawn. If every farm in a community possessed a regulated forest tract it would add as much beauty to the community as any other form of improvement that might be made from the standpoint of looks, and, so far as actual benefit to the owner, it would be of far greater value than many improvements that are made at greater cost and which yield no financial benefit in return. (This feature of the ethical value of the farm forest tract will be further discussed under the topic of farm arrangement in determining the location of the forest tract.)

The feature of erosion is a matter that in many parts of Indiana is perplexing to farmers, especially in the rolling land sections. There are but few farms which do not possess places where the soil washes badly, and not only works damage to the eroded lands, but injures growing crops in the path of the wash. It is an unsightly spectacle to see portions of a splendid farm gullied and laid waste by erosion. Trees planted in such places will hinder the washing away of the soil and obviate the spectacle.

The extent of damage by erosion is seen greatest in the drainage conditions. The unlimited removal of forests has left but small resistance to the flow-away of the rainfall. The water has nothing to hold it and conduct it into the soil, and store it for a gradual supply to the streams and springs. It speedily flows over the surface, carrying with it the soil and debris, and deposits it within the beds of streams until many former prominent creeks are now obliterated or are only a succession of stagnant pools for the greater part of the year. It has become so that the larger rivers of Indiana, formerly noted and beneficial for navigation can no

longer be used, and for portions of the year are almost dry. Any citizen of Indiana for the last quarter of a century can readily recall instances of such within his own observation.

THE LOCATION OF THE FARM FOREST TRACT.

The present woodlots upon the farms are sadly defective in many features. They are poor in the species of trees they contain, are located on the remotest parts of the farms, are in a deplorable, unsightly condition as a result of the reckless cutting of timber, fires burning through them, and the permission of grazing, and the area does not possess a sufficient stand of trees to form a mulch to keep down grass, weeds and other spontaneous growths. The tract of timber which now happens to remain is simply the culls of every kind that has escaped the market because of its quality. The average woodlot does not contain enough merchantable timber, if sold, to pay the taxes on the farm, and is the remote rubbish spot of the farm, and shows no indications of care in any form. When timber is sold or cut for the uses of the farm, no care is observed in falling the trees to save them or the younger growth. The trees are cut and slashed in every direction, and the parts of the tree not used for lumber are not cleared away to prevent injury to the growing timber, but are left in the form in which they fell. The tops and unfit parts for lumber are not made into fuel, posts or other farm use material, for which they might be used, and the smaller brush neatly piled or burned to rid the wood land from the dangers of fire, which sooner or later comes and burns through them. Stock is permitted to pasture in the woodlot constantly, and thus any new growth is grazed down, the humus is destroyed, and grass, weeds, and briars assume control of the soil, and further progress is at an end in such places.

The present farm forest is not located by choice but by accident or the result of circumstances. It is difficult to see in the present location of the wood tract on the great majority of farms any indication of a system of relationships in the arrangements of the farm buildings, orchards, drives and fields. The first settlers usually selected a high, dry location for their buildings, regardless of the position for farm arrangement, and it is not infrequent to find that though the buildings have been many times renewed

the site has never been changed. Clearing naturally began around the site selected for the house, and was extended in all directions unless hindered by boundary lines, public highways or directed prominently in some course because of fire spreading from the clearing and causing a deadening in the forest, which was followed by clearing off the burned-over region. From one cause or another, but without choice, the present farm woodlot occupies the location it does. It performs, perhaps, no function of farm protection, is a source of hindrance to the best use and management of the farm, and may occupy the best farming land. In the consideration of the farm woodlot, with a view to arranging for its permanence and the best service to the farm, it may become necessary to abandon the present timber tract and plant anew. In many instances there can be no question but that such is the thing to do, and it is now time to give the subject a sincere thought and put the same into active conduct.

To attempt to here offer a definite working plan for the location of the farm forest and general arrangement of the farm thereto would be folly. Some plans giving a partial idea of the same, it is thought, will add strength to the idea herein given, and the working plans given by Hon. George L. Clothier, Assistant Forest Inspector to the United States Department, are submitted. It must, however, not be forgotten that each individual farm will have to be the unit of consideration in the plan to be used. The plan of A's farm can not be fitted to B's unless all their parts and the purposes of the same are equal and the same. It would be the same as attempting to make the same boot fit every and all kinds of feet.

PREPARATION OF A PLANTING PLAN.

As a machine of production a farm should have a plan which provides for the best use of its every part. The woodlot or forest plantation should be in a position to contribute to the successful operation of this plan, for the trees may affect the atmospheric drainage, the wind currents, and the humidity of the air about the home. At the same time a planting plan must provide for sites which will produce the best possible growth. The arrangement of the fields and the location of the fences, private lanes, drainage systems, buildings, and farmstead should all be considered before any forest planting is undertaken.

Very rarely indeed have farmers deliberately planned the location and make-up of their forest plantations with reference to the needs, con-

venience and economy of their farms, and the relative value and adaptability of the trees to be planted. Woodlots have sometimes been so poorly located as to do actual damage to farms. Cases have been observed in the northern half of the Middle West where windbreaks planted too close to the buildings caused the drifting snow of severe winters to bury the houses 15 or 20 feet deep. In the winter of 1899 a farmhouse in the Red River Valley, North Dakota, was buried in a snowdrift for three months because a cottonwood grove had been planted too near it. In other cases trees have been planted near tile drains, which the roots clog.

It is probable that not one-tenth of American farms are being operated under any permanent system of management. Before forest planting is undertaken some such system must be adopted, however, in order to make the future existence of the forest plantations possible, for more than half the planting plans made since July 1, 1899, by the Forest Service, fundamentally affect the future management of the farms. As very few farmers are accustomed to formulating farm plans, the agent of the Forest Service, besides being called upon to give advice in matters pertaining to technical forestry, is usually drafted into this service as well. After consultaton with the landholder and consideration of all the matters affected by the policy of management, he is able to bring out an orderly arrangement which will permit on the same farm the practice of both scientific agriculture and scientific forestry.

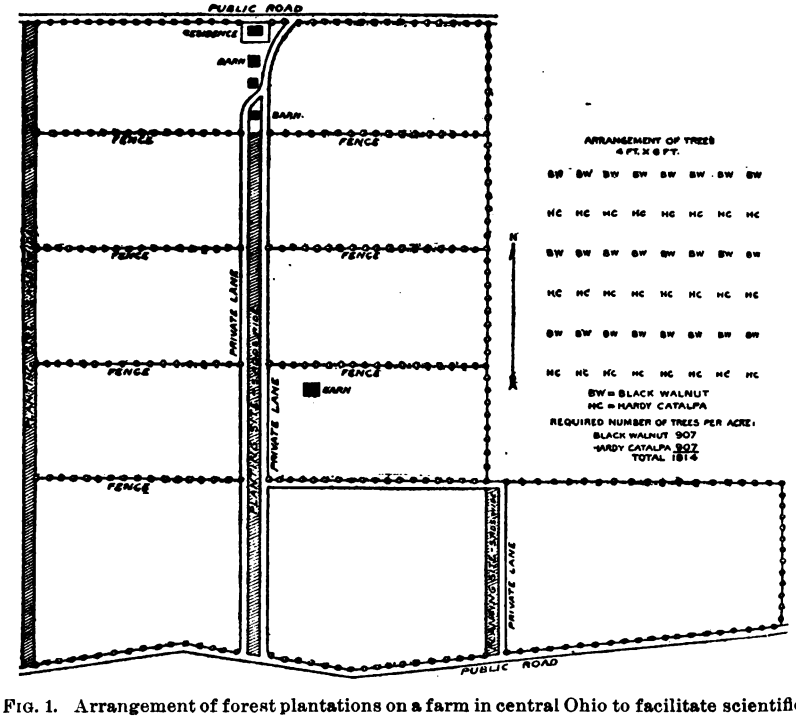

FIG. 1. Arrangement of forest plantations on a farm in central Ohio to facilitate scientific farm management.

A CONCRETE EXAMPLE.

The planting plan shown in Fig. 1 was made for a farm in central Ohio, and illustrates graphically the bearing that forest planting may have on the management of a farm. This farm in Ohio contains 375 acres, and that part of it which is devoted to agriculture is capable of earning interest on a capitalization of $100 per acre; not a foot of it is unsuited to tillage. That part which was originally heavily timbered has all been cleared, except a blue-grass pasture of 30 or 40 acres which is occupied by the remains of the original forest, consisting of a scattered stand of declining sugar maple and beech trees. This timberland embraces the most fertile part of the farm, and interferes most seriously with the convenient and economical division of the farm into fields. If the Forest Service had advised the owner to attempt to rejuvenate the dying trees and to underplant them with expensive nursery stock, the instructions would have been implicitly followed, but such advice would have wrought a positive injury to the landholder. Instead, the planting plan advises that the forest area of the farm be reduced by clearing the only natural timber left standing, and that, instead of retaining the scattered growth now cumbering the pasture, trees sufficient to occupy half the present forest acreage be planted in such positions as to protect the farm from the severe westerly winds prevailing in the region.

The owner was therefore advised as follows:

(1) The major portion of this farm is too valuable for agricultural purposes to be devoted to forestry. The native timber now scattered over the pasture is rapidly declining, and is reduced by every hard storm. No natural reproduction is taking place, and while the land is grazed none can be secured. The location of the scattered trees in the middle of the farm would require expensive fencing in order to protect them from live stock. Thus, it is believed that the rejuvenation of the old forest on this farm is impracticable. Instead, this land, as soon as the old trees have all disappeared or been removed, should be laid out into permanent fields. As every well regulated farm, however, should possess some timber land to supply it with fence posts and to furnish shade and shelter for live stock, new plantations are recommended. The trees will take up as little room as possible, while the arrangement of the fields in rectangular blocks will greatly facilitate the use of modern machinery.

(2) The chief plantations should occupy strips of five rods wide, running from north to south. One of these strips should be planted on the western border of the farm and another crossing its center due south of the residence. A third should cut off the block extending east from the southeast corner of the main rectangular tract. In addition to these strips, it is advised that single rows of trees be planted on the division lines between the fields, so that they may be used as live posts upon which to fasten wire to form fences. (See Fig. 1.)

(3). Black walnut and hardy catalpa should be used in equal proportions for the belts, and should be planted every four feet in alternating rows, which would be six feet apart. The walnut seed should be planted two years prior to the introduction of the catalpa seedlings, in order to allow the slow-growing walnut to get a start before being crowded by the

catalpa. The nuts of the walnut should be collected as soon as ripe in the fall, and should either be stratified* in moist sand or planted immediately in their permanent site. These nuts should never be allowed to dry out after ripening. They are most easily planted while plowing, by dropping them in a furrow and covering them with the next furrow slice. If walnuts are thus planted the squirrels are not likely to find them. The ground between the rows during the following two years should be planted with corn, and should receive good tillage. This can best be done by the use of the lister. After the catalpa seedlings are introduced no more corn should be planted, but the ground should be cultivated as long as a single-horse cultivator can be run between the rows. Catalpa seedlings 12 to 16 inches tall and one year old should be used. They can be obtained from dealers for $1.50 to $5 a thousand. The labor of planting these seedlings may be performed chiefly by horsepower. Both walnut and catalpa should be planted in accordance with the diagram shown at the right in Fig. 1.

By consulting the illustration the reader will see that the planting plan subdivides this farm into eleven fields—eight rectangular ones of equal area and similar dimensions, and three of nearly equal area but of unlike dimensions. This division will permit the application of scientific crop rotations, the eight rectangular fields being suited to two systems of four-year rotations and the three irregular fields to one three-year rotation. The convenient shape, ease of cultivation and wonderful fertility of this farm present an excellent opportunity for the arrangement of such rotations of suitable crops.

Trees planted on the lines which separate the fields will serve as windbreaks as well as living fence posts. A method adopted by some is to plant Osage orange hedges between the fields, and every 20 feet to allow one of the trees to grow to its natural height. The remaining trees should be pruned to a height of 5 feet and kept within proper limits for a hedge. Then, if this growth proves inefficient as a fence, it can be reenforced by fencing wire stapled to the large trees. If the Osage orange is undesirable or a hedge is not wanted, chstnut should prove a desirable tree for the fence lines. The young trees should be planted about 20 feet apart, and when they begin to crowd each other every alternate tree should be cut out. Round-headed and with sturdy trunks, these trees will form very effective windbreaks for the intervening fields. Their nuts will bring a satisfactory return for the land they occupy, and the trees which are cut out will furnish excellent fence posts. The substitution of straight woven wire fences for the old zigzag ones of rails transforms the fence lines from breeding places for noxious weeds into productive land upon which the living fence posts grow into a merchantable product.

Such a plan as this fixes the boundaries of the fields, locates the private lanes, and, in fact, forms the skeleton of any future system of farm management that may be applied to this farm.

*Stratification is a method of storing forest seeds to prevent them from drying out The seeds are stored in alternating layers between layers of moist sand.

A MODEL PRAIRIE FARM PLAN.

In order to illustrate a model prairie farm plan made in accordance with sound principles of forestry, Fig. 2 has been prepared. This farm plan is applicable to a large region in the prairies of the Middle West, where windbreaks are necessary to the full development of the country. It assumes that the land is of uniform condition of soil, and has been surveyed by the rectangular system adopted by the government. The

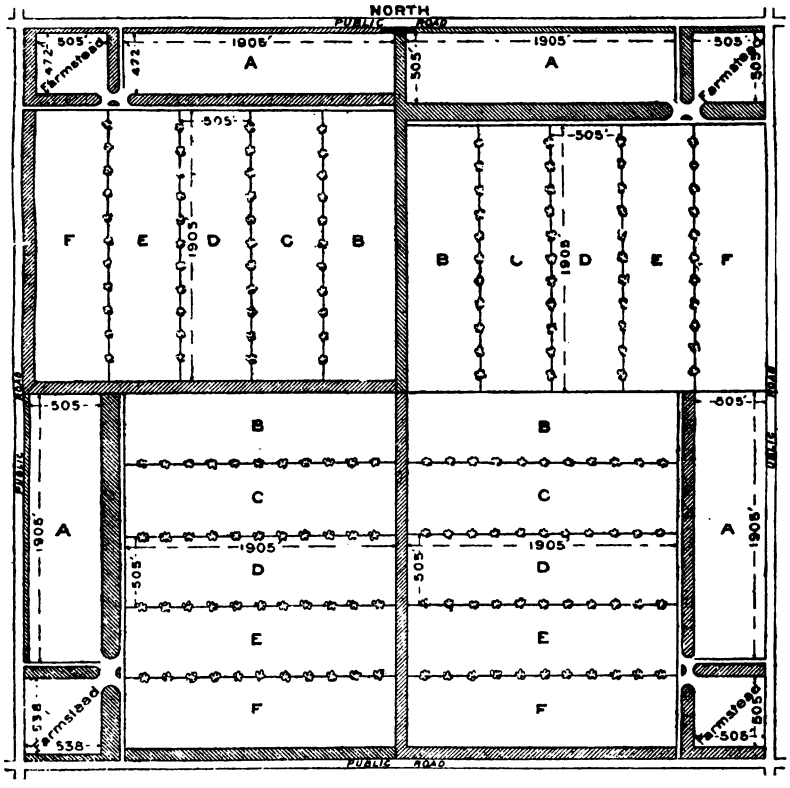

FIG. 2. Ideal plan of the four quarters of a section with location of forest and windbreak plantations—suited to the prairies of Kansas and Oklahoma.

public roads are supposed to be located on the section lines. The application of this model to a country with its surface broken by creeks or lakes would, of course, necessitate a modification to fit local conditions. The plan is intended merely to illustrate principles.

Four farms of 160 acres each are shown, illustrating an arrangement suitable to each of the four quarters of a section. The farmstead, or that portion of a farm which is occupied by the residence, barn, orchards, gardens, lawn and feedlots, is here shown as placed at the section corner of each farm. While in a large proportion of cases the location of the farmstead will be determined by the particular conditions, as water supply,

topography, etc., an arrangement, where practicable, by which the houses stand on the section corners will be worth considering.

The fields on each quarter section have been laid out to permit the planting of windbreaks to protect the crops from the hot southwesterly winds of summer and the cold northwesterly winds of winter. The farmsteads are also provided with protection from winds. East winds have not been considered, because of their infrequent occurrence, but a general adoption of this plan on all the farms of a region would afford protection from all points of the compass.

The fields, with one exception, are all of the same shape and size, there being on each quarter section six fields, each 22.1 acres in area. This method of dividing the farm into fields will afford an opportunity for the application of a scientific system of crop rotation, and the fields, being six in number, will permit the application of a compound rotation embracing the use of a perennial crop like alfalfa in combination with five annual crops, where this is desired. If the use of a perennial is not desirable, the six fields will permit the running of two parallel three-crop rotations.

THE AMOUNT OF FOREST FOR THE FARM.

The question, what fractional part of a farm should be retained in forest? is frequently asked. To give a definite reply would not be wisdom, because the conditions in all instances of State and communities are not the same. More forest may be required in one locality than in another. Every effect and need would have to be known to make a positive assertion in answer to such an inquiry. Lincoln was once asked, by some able theorists who were discussing the perplexing problem of just how long a man's legs should be in order that he be the best physical type of soldier, for his idea. Without ceasing the duties in which he was engaged he replied, "I have not thought of the matter, but should judge they ought to be long enough to reach the ground." As near a positive answer as could at this time be made after careful study is that the fractional part should be large enough to supply every demand for wood upon the farm and a surplus for commercial demands besides. At the present prices for building lumber, the farmer who has disposed of all his timber and is required to buy for his building and fencing is far the loser, but the farmer who has been wise enough to save his trees sufficiently either for his own building and fencing and for commerce is exceedingly the gainer. The tract should be large enough to supply all building lumber, fencing and fuel and to yet have a good reserve for the local commercial demands. The area reserved should also be put to its

fullest producing capacity, and whatever fractional part estimated should be based on a full stand of growing trees.

By some the fractional part of the land which should be reserved in forest is given at one-eighth, by others as one-tenth. Some countries of Europe have laws requiring these fractional allotments for forestry of landowners. It would seem that in the best agricultural sections that a fair fractional estimate would be from one-twelfth to one-sixteenth of the land and in the hilly, broken sections of the country, where the land is not well suited to farming, that the area devoted to forestry should far exceed this amount. As without question broken land is far better and much more profitable when devoted to forest and fruit growing. An estimate of one-half to one-sixth would not be too large.

TREES TO PLANT IN THE WOODLOT.

Whatever may be the diversity of opinions as to what trees are best to plant for the various special uses as advocated by individuals supposed to be authority and experienced in such particulars, all will agree that the woodlot in Indiana can be planted to no better kinds of trees than those natural to the woodlands throughout the State. No more valuable trees could be introduced, considered from every viowpoint, than the white, burr and red oaks, American ash, black walnut, shellbark hickory, yellow poplar, wild cherry, American elm, sycamore, maple and linden. For fencing posts, cross-ties, telegraph and telephone poles the American chestnut, black locust, catalpa speciosa, osage orange, mulberry, Kentucky coffee tree and red cedar are the recognized trees to plant. The woodlot should contain a mixture of these two classes of trees, as the problem with the farmer now, and will be in the future, is lumber for building, posts for fencing, and wood for fuel, and in the field of merchandise one is sought as extensively as the other. The farm forest should be free from worthless species and trees of experiment should be given no room and time. Let the experimental stations develop all such doubtful points as growing trees, the character and quality of which in this country are unknown and doubtful.

METHODS OF PROPAGATION.

The method employed in the establishment of a permanent woodlot may be any of many, and whatever the one selected, it will result successfully if assiduously followed. The result of anything attempted and accomplished can not as much be attributed to the method of procedure as to the soul put into it by the undertaker. True a wrong method could not result in the best, no matter how much soul injected, but more will result from a poor method backed up by the ardent devotion of the performer than from a good method lacking any confidence and support. The heart and hand determinedly united in an effort, and a plan of action based on common-sense judgments, will result in success.

The methods here discussed are those now in vogue throughout the country in conducting forestry operations by students of the forestry profession, and the results where followed are good.

Regeneration of Old Forests.—In Indiana the problem of regenerating old forest woodlots is not surrounded with the difficulties of other sections of the country. The soil of our State is naturally a tree growing one. Wherever natural forest conditions are found a dense growth of trees prevail. Wherever unnatural forest conditions occur and the same are obviated a good growth of trees succeeds. The soil of Indiana by nature was covered with forest trees and its tendency is to return or remain so. Thus the first prime element, tree growing soil, is natural. The climatic conditions are not, however, the best, owing largely to the fact of the changed soil covering caused by clearing off the forests. This changed condition has an influence as given under the preceding topic, "Climatic Benefits."

If a woodland retains its forest conditions of humus and is free from sod growth, regeneration is an easy task. By simply keeping stock from the area desired to reforest, and preventing fires from burning through the woods, a few years will develop a dense undergrowth of trees. If the area possesses the reverse conditions because of having long been used as a pasture land, then the process is a different one. Also if the old forest consists largely of low spreading beech, the problem requires a different consideration.

Where a woodlot has been used as a pasture land until the

humus is destroyed and a dense sod formed, the process giving the best results is as follows: Thoroughly break up the sod in some convenient manner, as plowing or permitting hogs to root it up, which they will do if given the opportunity, because of herbs, roots

A view of the average farm woodlot where stock has not been permitted to graze the past summer, and showing the natural growth of young forest trees springing up.

and insect and worm life under the sod, which they desire as food. The plowing, if decided upon, may be performed during the late fall and early winter, after the busy season is past. It should be performed at such time so that the winter's climate and changes will completely disintegrate the soil and sod and restore the ground

to a fit condition for seed without labor. Usually when a woodland is so treated and all stock is removed a dense growth of trees spring forth from the seeds that have been lying dormant beneath the sod and waiting for liberty. This method can be greatly aided, however, by scattering on the surface, after the plowing is done, seeds of the kinds of trees most desired. The winter's action on the soil will cause them to become sufficiently imbedded to take root and grow as soon as spring returns and new life begins. The

View of a farm woodlot in which stock has been permitted to graze constantly, showing no young growth of trees springing up.

seeds of whatever kind desired can be secured during the autumn and stored in a cool, dry, airy room in anticipation of the work.

Should the trees of the old woodland be mostly large, low-spreading beech, the first step should be to remove them, since the dense shade afforded by them does not permit of growth under them, and the denseness of their foliage is such as to stunt any growth in the path of their shade. Masses of all kinds of winged seeds which are carried by the breezes drift and lodge under them and when they are removed so that the sunlight and heat can penetrate the soil, usually a dense growth of ash, maple, elm, poplar and such

trees which possess seeds that may be carried in the air grow up at once. A growth of hickory, oak and walnut may be secured by scattering seeds as described above.

These methods followed in the regeneration of old woodlots will result in success beyond the expectation of most persons, especially those who have not given the subject proper thought.

Either of these methods employ different processes of operation. The whole area may be gone over at one time or season, strips may be gone over season after season until the whole is completed or patches throughout the area may be treated and these enlarged year after year until thy converge and thus cover the area. These processes are known respectively as the "compartment," the "strip" and the "group" systems of regeneration.

By the "compartment" plan the whole area to be regenerated is seeded and cultivated in the same seed year, but it entails difficulties which only the most perfect conditions could obviate.

Under the "strip" plan the regenerative process is conducted over strips instead of over the whole area to be cultivated. The strips are treated so as to have three receiving attention at the same time; one being in the completed stage, one in the stage of seeding, and one in the stage of preparation. The breadth of the strips is determined by the influences under which the owner is acting. The operations should be begun on the most permanent side and extended one after another till the whole tract is treated. In this manner the work will be performed and different stages of timber will be growing.

The "group" system may be viewed as a modification of the "strip" system. Under its workings different patches are regenerated at intervals over the forest area and these are then enlarged by the same three stages of operations till they converge, and the whole area is thus regenerated. The main objection to this system is the unevenness of forest it produces. It is one of the most convenient means where good seed trees exist to spread out from them. In almost every forest some good trees are standing which may be made nuclei for regenerating. It is a good plan where the varieties are desired in groups as opposed to a general mixture.

Many considerations which should receive the most careful study enter into these regenerating processes. The porosity, moisture and humus are factors which the soil itself must possess in

right relations. The climate and denseness desired are other important features. It may require much artificial assistance to get these relations in accord. In cases of too much humus and rubbish the same must be removed before the seed is sown. If the humus is deficient the soil will have to be worked by such means as hoeing, plowing or harrowing. In cases of sod the same course must be pursued. If too much shelter exists trees should be removed until the proper shelter and light are secured. Good conditions exist when enough shelter is obtained to prevent weed and sod growth and the soil is seen in half mixture with humus. When such conditions prevail the seed will sink readily into the soil and the roots of the germinating seeds can penetrate for sustenance. It is advisable to at all times, for seed planting, prepare the soil by working it.

The cutting of timber preparatory for this regeneration of forests consists in removing all trees except such as are retained for seeding and to properly shade the ground. The successive cuttings will be determined in frequency by the size of the timber to be marketed or used. When once the forest has been regenerated so that trees for seeding properly may be retained over all parts of the tract, the idea in the "compartment" system can be executed very well.

If the plans are followed, and good seeds from the best varieties of valuable trees are secured and planted, the woodlot will be all that is desired and the whole country will be more valuable and beautiful.

In regenerating the woodlot, or in the planting of new areas, roadways should be left at intervals for getting into the forest for the removal of timber when desired. It will be found beneficial to do so.

How to Grow Young Trees For Forest Planting.

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THE FARMER'S NEED OF A HOME NURSERY.

Forest planting by small landowners is an important line of forest work, and in many sections of the United States is a recognized adjunct to successful agriculture. It had its beginning long before forestry became a subject for general economic consideration, and the settlers of the Middle West planted trees for years before there was a professional forester in this country or recognition of the subject by the National Government. The results are now apparent in the form of planted groves and windbreaks of mature trees in many regions, particularly in the prairie States. In Nebraska alone the average of the returns of the assessors for 1903 and 1904 showed an area of 286,000 acres of planted timber. Many mistakes were made by the early tree planters, and much of the timber now standing is of little commercial value, because the primary desire was for quick effects, which were secured by using rapid-growing species of poor quality and short life. From the standpoint of protection very satisfactory results were obtained, but in future planting the use of trees which will not only serve for protective purposes, but also produce timber of higher value for posts, fuel, and lumber, is strongly urged.

The farm windbreaks and shelterbelts and the small planted groves which furnish fuel, fence posts, and repair and construction material constitute one of the less striking phases of American forestry today. Considered, however, from the standpoint of the greatest good to the greatest number, their value to the vast host of citizens who follow agricultural pursuits becomes apparent, and their contribution to the prosperity of the West is realized.

Practically every section of the country can be helped by more intelligent and extensive forest planting by small landowners. By

this means the abandoned farms of New England can be made productive, the best kinds of shelterbelts and woodlots secured in newly irrigated sections, the needed protection given to field crops and the necessary wood material produced cheaply on the treeless plains and prairies, and the whole country made more attractive as a place of habitation. With the development of the semiarid West through the reclamation of large areas by irrigation and dry farming, an entirely new field for forest planting as a farm crop is opened up. One of the functions of the Forest Service is to encourage this work by determining the species most suitable for every situation and region, and by giving advice as to the most economical and effective methods of planting and protecting the young trees.

One of the most potent influences which retard forest planting on farm lands is the difficulty experienced in securing suitable planting material save at almost prohibitive cost. Until recently very few nurserymen attempted to raise forest tree seedlings, and the demand was so uncertain that high prices were charged as an offset to the uncertainty attendant upon the disposal of the stock. The high initial cost of nursery-grown seedlings, the expense of shipment, and the uncertainty of receiving the young trees when wanted have had a very discouraging effect on the small planter, and the establishment of plantations has been curtailed in consequence. On the other hand, home production of young trees has seemed too difficult a task for the novice; while the rush of farm work at the time seed beds should have the most attention, together with the lack of reliable information as to how to grow forest seedlings, has generally checked all efforts along this line.

It is the object of this paper to show that it is not difficult or impracticable to grow the young trees needed for ordinary farm planting. If a corner of the garden is devoted to this purpose, and as much care and attention is given to the work as is necessary for the successful production of common garden truck, there is no reason for failure.

The suggestions here given are intended to apply only to the production of young trees for home use, and by the simplest methods which will insure success. The use of home-grown nursery stock should greatly reduce the initial cost of a plantation, whether it be

composed of 500 or 50,000 trees, and should result in more extensive forest planting on the waste places on farms, and in general for purposes of protection and wood supply. The care necessary to grow successfully young trees for planting, and the time required, which is one year for broadleaf trees and two or three years for evergreens, are more than compensated by the saving in cost and the better results secured.

COLLECTION, PREPARATION AND CARE OF SEEDS.

The fundamental step in growing young trees is to secure good seeds of the species desired. If fruiting trees are close at hand, the seeds may easily be collected; otherwise they can be ordered from seedsmen for delivery when needed in the spring. The short-lived seeds of silver and red maple, elms, willows, and river birch, which mature in the spring, are rarely handled by dealers, and should be collected promptly when mature and planted at once. The fruit of all other important species ripens in late summer or fall, and, with the exception of the aspen and cottonwood, may be preserved over winter.

The short-lived seeds can best be collected by catching them in sheets or blankets as they fall, or by sweeping them up from the ground. Acorns and nuts can easily be gathered from the ground, while pods, seed-balls, cones of all kinds, and fruits of the cherry, hackberry, and ash can be most easily secured by picking from the trees when mature. All acorns from the white oak group should be collected as soon as they fall, for they will soon germinate if left on the ground. In collecting, care should be taken to gather seeds only from vigorous, well-formed trees, and to be sure of the identity of the species. This is essential, particularly in the case of catalpa, because the hardy catalpa (*Catalpa speciosa*) is the only form worthy of propagation, yet it is hard to distinguish it from many hybrids. In case of doubt, specimens of seeds should be sent to the seed-testing laboratory of this Department, where they will be identified and their vitality determined without charge.

With many species some treatment is necessary in order to separate the seeds or nuts from their covering. The hulls of the hickories may be removed readily when the nuts begin to dry; walnuts may be run through a corn sheller or forced through an

auger hole when green to free them from the thick shuck, or they may be placed in piles until winter to allow the shucks to rot; the seeds of pulpless pods, such as the black locust and catalpa, should be shelled out by hand when dry; the fleshy fruits of honey locust, Osage orange, mulberries, etc., require macerating in water until the seeds are separated, after which they should be spread in thin layers and dried slowly. The thin-scaled cones of evergreen trees and of the yellow poplar (tulip tree) and birches open readily in most cases upon drying. The cones should be spread on a smooth surface in the sun or in a warm room, and, when open, the seeds may be shaken out and the cones removed. In the case of firs, yellow poplar, and birches, however, the cones fall apart when dry. A few of the pines, as the jack pine, pitch pine, knobcone, and others, have cones which will not open without artificial heat, but they rarely come into consideration in a home nursery. In separating seeds from the scales, wings, or dirt with which they may be mixed, a sieve can be used, and in many cases light dirt may be removed by pouring the seeds from one receptacle to another in a current of air.

The seeds of nearly all species are better for a little careful drying after they are gathered or extracted, to remove all superficial moisture. This is preferably done in a cool, airy place where the seeds can be spread in thin layers and stirred frequently. An earthen floor is the best place for nuts and acorns. Since weevils are very destructive to most nuts and acorns, all seeds of this kind should be treated with carbon bisulphid before being put into winter storage.

Upon the care given to the winter storage will largely depend the vitality of the seeds in the spring. The pines, spruces, larches, firs, cedars, birches, mulberries, locusts, Osage orange, black cherry, and catalpa should be stored in sacks hung in a cool, dry place away from mice and rats. All acorns and nuts should be layered, or "stratified," in sand, preferably in a pit out of doors, where they will be subject to thawing and freezing. Good drainage is absolutely essential. The best plan is to dig a pit about 18 inches deep, place 5 or 6 inches of coarse sand or gravel in the bottom, on this spread a layer of nuts not to exceed 3 inches in depth, and then fill in above with leaves, chaff, or straw, with 6

or 8 inches of dirt on top, well rounded so as to shed water. If mice or squirrels are likely to disturb the nuts, the sides of the pit should be lined with boards. The smaller seeds, such as sugar maple, hackberry, boxelder, red cedar, coffeetree, yellow poplar, and ash, can also be kept most safely by layering in sand, although they will retain much of their vitality if kept in a uniformly cool, dry place. If stored in sand, it should be in boxes, either in a cellar or in a cool outbuilding.

THE TIME TO PLANT.

Nursery planting should ordinarily be done in the spring. The exact time varies with the location and season, but a good rule is to plant the tree seed when the soil and weather conditions are such as would be favorable to the planting of early vegetables.

TWO KINDS OF NURSERY REQUIREMENTS.

The forest trees adapted for farm planting fall into two groups which require very different methods of nursery treatment. The first group is composed of conifers, or evergreens, which must be grown in partial shade, left in the seed beds two years, and preferably once transplanted to open nursery rows before they are set in their permanent places; the second comprises the broadleaf or deciduous trees, which may usually be grown without shade and set out permanently the first spring after planting, when they are one year old.

Each of these groups will be treated separately, and the suggestions made general to cover as nearly as possible the wide range of country and the varied conditions under which planting is advisable.

CONIFEROUS TREES.

Under this head the trees which would ordinarily be grown for forest planting are white, red (Norway), pitch, jack, Scotch, western yellow (bull), Monterey, and Coulter pines; white, red, Colorado blue, and Norway spruces; European larch; arborvitæ; and balsam and red fir (Douglas spruce). The nursery methods outlined would apply as well to the less commonly used species.

THE NURSERY SITE.

In the selection of a nursery site it should be the aim to have a convenient location where there will be no danger of disturbance by stock or birds, and where the soil is a moderately fertile sandy loam, well drained and as free as possible from weeds. For a nursery with a productive capacity of a few thousand seedlings there is seldom a better location than a section of a vegetable garden. If the ground is lacking in fertility or is covered with sod, it should be enriched and thoroughly worked, as for a garden site. Knowing the number of young trees desired, the area necessary can be roughly approximated by figuring on 3,000 seedlings per 100 square feet of ground, the assumption being that about half of this total space will be covered by seed beds, the other half by walks and paths. In nearly all regions it will be found convenient to have the nursery near a windmill or other source of water supply.

SIZE AND PREPARATION OF SEED BEDS.

The most satisfactory width for evergreen seed beds is four feet. This is convenient for weeding and transplanting, and permits the use of the usual lath shade screens. The beds may be of any length which will give the required ground space. Instead of having one long, solid bed, it may be broken up into 12-foot lengths by paths of a foot in width. If several beds are made parallel, they should be separated by walks two feet wide. On sloping ground the beds should run crosswise to the slope, in order to minimize washing during heavy rains.

The preparation just prior to planting need in no wise differ from that which would be given an onion or lettuce bed—a thorough spading and raking, sufficient to pulverize the soil and leave the surface smooth and moist. On dry, sandy soils it is not advisable to make raised beds, but where drainage is desired the top of the bed should be a few inches above the general level of the paths.

PLANTING THE SEED.

For small seed beds, sowing in shallow drills will usually be found preferable to broadcasting. The drills should run across the beds and be from 4 to 6 inches apart. Double drills 1 inch apart

with a 6-inch space between them are sometimes used. The drills can be marked conveniently by using a board 4 to 6 inches wide, according to the space between the rows, and using one side as a straightedge along which a stick can be dragged in making the drill. A somewhat more rapid method is to nail small three-cornered cleats to the bottom of a broad board, at the required distance apart, and mark the drills by pressing it down on the top of the bed. For example, if the drills are to be 4 inches apart, a 12-inch board should be used with three cleats, one on the edge and the two others at distances of 4 and 8 inches, respectively, from it, the edge without the cleat being placed at the drill last made in moving the board. Handles on top will facilitate its use.

Where the soil is free from weed seeds, and a high production per unit of ground space is desired, broadcast sowing may be practiced. Jack pine and Monterey pine have been found to do particularly well when sown in this manner. The seeds which are sown broadcast may be covered by scattering or sifting fine soil over the surface to a depth of about one-fourth inch, or by merely pressing the smaller seeds into the ground with the board.

The depth at which seeds should be planted depends upon the size of the seed, character of the soil, and conditions of moisture. In sandy soil and in dry climates where the beds are not sprinkled they should be planted deeper than in heavier soil or where rain is abundant. A good general rule is to cover all seed to a depth of about twice their diameter. The ordinary tendency is to plant too deep.

QUANTITY OF SEED REQUIRED.

The amount of seed to be used depends on the species and the percentage of germination. For example, 1 ounce of western yellow pine seed will suffice for 16 linear feet of drills, while an ounce of the smaller seed of Scotch pine and larch will cover about 60 linear feet of drills, or one-third to one-half pound will be sufficient for 100 square feet of seed bed when planted in 4-inch drills. With white pine three-fourths of a pound will be required for the same space, while with fir, on account of its low germination percentage, 2 to 2½ pounds should be used. As a rule the firs, larches, hemlock, white cedar, and red cedar, on

account of their lower germination percentage, and white pine, because it germinates slowly and may lie over until the second year, should be planted proportionately thicker than other species. With the above-named species the seed should be so scattered in the drills as to form a continuous row, so that on the average, if placed end to end, the seeds would all touch each other. With the other species, such as spruces, larch, and all pines except the white pine, the average number planted should be such that a seed should alternate with an open space equal to its width.

PREPARATION AND PROTECTION OF THE SEED.

In sowing most coniferous seeds no preliminary treatment is necessary, except that in certain cases it is wise to coat them with red lead, to prevent their being dug out and eaten by birds and squirrels. Red cedar seeds, however, should be soaked for four or five days in warm water, followed by two days' soaking in lye made from wood ashes. Even with this process the red cedar is a difficult tree to grow, and its use is not recommended. In all cases provision must be made to protect the nursery from birds and animals. In semiarid regions provision must be made for watering the beds, either by hand sprinkling with a watering pot or by the use of a hose. Subirrigation is seldom advisable.

PROTECTION OF THE SEEDLINGS.

A thin surface dressing of fine gravel or coarse sand applied just after the seed is sown has been found to be effective in preventing the young seedlings from "damping off." The seed bed should be kept as uniformly moist as possible, in order to insure prompt germination, and artificial shade should be provided from the time the seeds are sown.

Under normal conditions seeds should begin to break the ground in from ten days to three weeks after planting, the time depending on the species, soil and climatic conditions, and depth planted. In the case of white pine the bed should not be disturbed, even though no plants appear for a longer period than this. Weeding should begin as soon as the plants are well up, and should be continued throughout the season. When conditions of drought prevail, the

surface between the rows should be loosened frequently to assist the conservation of moisture. "Damping off" will be the greatest danger to threaten the young plants. By keeping the ground stirred and removing the shade frames to let in light and air during damp, cloudy weather, the danger can be somewhat reduced.

In regions where the winters are severe it is advisable to mulch the seed beds in order to prevent the seedlings from cold, drying winds and to prevent their being heaved out by frost in the spring. Leaves, moss, chaff, or any similar substance which is free from weed seeds, will serve as a mulch. The beds should be covered three to four inches deep. The mulch may be prevented from blowing by laying pieces of boards or sticks crosswise between the rows. It should be removed at the beginning of the growing season. In the Southwest and on the Pacific coast, or wherever the ground does not heave and the cold is not severe, mulching may be dispensed with.

One of the prime essentials in growing coniferous seedlings is to keep them under partial shade the first two years, while they are in the seed beds. When transplanted, the shade may be dispensed with. The desired shade is usually secured by a frame covered with laths (fig. 59). The simplest form is a frame 4 by 12 feet, made of 2 by 2 inch sticks, across which laths are nailed, each lath alternating with an open space, the same width. The frame is supported on posts or edgings so as to be about 18 inches above the seed beds. In a permanent nursery the frames are often hinged to posts, which enables them to be readily moved, but in the home nursery a more simple support will serve the purpose. These frames should remain over the beds except in cold, cloudy weather, when the plants show a tendency to "damp off."

TRANSPLANTING SEEDLINGS.

Except a few rapid-growing California pines, all evergreen seedlings should be kept in seed beds until two years old. At the end of this time they should be transplanted to nursery rows or set out in their permanent sites. The best young trees for planting are those which are three years old, once transplanted, but it is a most decided economy of time and cost to use two-year old untransplanted seedlings when this can be done successfully. Where

the planting site is favorable, and grass and weeds will not crowd the young trees, satisfactory results may be expected from the use of two-year-old plants. If western yellow, Coulter, or Monterey pine of this age is used, it is an excellent plan to root-prune the seedlings in the beds when they are one year old or the fall before they are set out. Root pruning with other species also is beneficial, but not absolutely essential. The roots should be pruned with a flat spade or a tool which is made especially for the purpose.

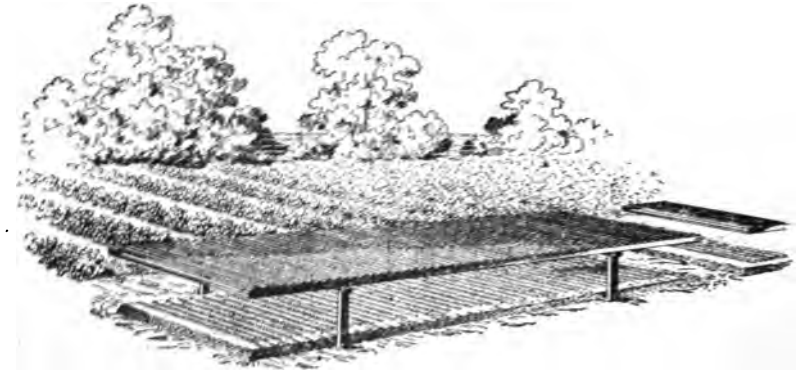


FIG. 59.—Protecting young seedlings from the sun by means of shade frames.

They should be cut off from six to eight inches below the surface of the ground.

To secure three-year-old, once-transplanted stock, the seedlings should be dug from the seed beds the spring of the second year and set out in the open four to six inches apart, in nursery rows. These rows may be six inches, one foot, or three feet apart, according to whether hand or horse cultivation is to be given them. Parallel rows one foot apart permit the use of hand cultivators. For a small number of trees closely spaced rows in a bed of any convenient size are probably best. In transplanting, the greatest care should be exercised to keep roots from becoming dry even for a moment, by carrying the seedlings, roots downward, in pails containing several inches of water.

BROADLEAF TREES.

This group includes the commonly planted broadleaf trees, such as the maples, locusts, catalpa, ashes, elms, Osage orange, mulberries, oaks, chestnuts, walnuts, and hickories. In the nursery

these trees require no shade and should be planted in their permanent places in the field when one year old. This should be done in the spring. The methods outlined below apply to the short-lived seeds of cottonwood, elms, willows, and silver and red maple, which must be planted as soon as mature, as well as to seeds which may be kept over winter.

The directions given under coniferous trees for the selection of the site and the preparation of the ground for a nursery of evergreens will in general hold for broadleaf trees as well. One essential point of difference is that to grow the same number of seedlings more ground space will be required in the broadleaf than in the evergreen nursery. Although shade frames are not necessary, it is advisable to locate the seed beds for broadleaf species to the east or north of trees or buildings, where partial protection from the sun will be secured.

PRELIMINARY TREATMENT OF SEEDS.

In order to secure prompt germination, preliminary treatment must be given certain of the broadleaf-tree seeds prior to planting. Those with thin seed coats, such as the ashes, maples, elms, Osage orange, basswood, yellow poplar, and catalpa, need no treatment. On the other hand, those with thick, strong shells, as the walnuts, hickories, oaks, and chestnuts, germinate freely only when preserved in sand out of doors during the winter, so that the shells become softened and partially decayed or are opened by frost. Another class of seeds, such as the locusts, coffee-tree, mulberries, and hackberry, require soaking in hot water in order to become softened enough to sprout quickly. The best plan is to place them in water heated nearly to the boiling point, about two quarts of seeds being used to each pail of water. The mixture should be stirred until cool and then allowed to stand four or five days, at the end of which time the seeds found floating on top should be skimmed off and planted immediately, and the process should be repeated with the remainder. It is very essential that seeds thus treated be planted without being allowed to dry out, and it is equally necessary that those stored in sand over winter be placed in the ground as soon as they are removed from the sand.

PLANTING THE SEEDS.

The seeds of the common broadleaf trees should be planted in long rows. If only two or three thousand are to be grown, the rows may be a foot apart and the cultivating may be done by hand. For greater quantities it is best to have the rows two feet apart when a hand cultivator is to be used, or about three feet apart for horse cultivation. The general arrangement and treatment should be similar to that given peas when grown for market. With ordinary success 100 linear feet may be expected to produce about 300 trees.

As with conifers, the spacing of the seeds in the row depends largely on the germination percentage. In general, fresh nuts and acorns of good quality should be planted two to three inches apart in the row, while the ashes, maples, catalpa, elm, hackberry, locusts, box elder, Osage orange, and others with an average percentage of germination above 50 should be spaced from three-fourths inch to one and a half inches apart. Those of abnormally low germinating power, as the basswood and yellow poplar, should be sown three or four seeds deep. Except in the case of short-lived seeds, which mature in late spring or early summer, all nursery planting should be done as early in the spring as the ground can be worked.

The rule as to depth of planting already given for coniferous seeds holds good also for broadleaf species. The depth should never be greater than three times the diameter of the seed. In dry seasons, or if a period of drought follows planting, moisture can be conserved and germination hastened by covering the rows with a mulch of straw or leaves. This should be carefully removed as soon as the seeds begin to break ground. Frequent cultivation should be given throughout the first season in order to kill the weeds and to keep the ground loose and moist.

TRANSPLANTING SEEDLINGS.

Most hardwood seedlings will be large enough to set out in the field the first spring after sowing. An exception must be made in the case of a few of the slower-growing trees, as the elms and birches, or when dry weather, late planting, or an unfavorable location prevents the seedlings from making a normal growth. As a

rule, if the average height is above 8 or 10 inches, the seedlings should be transplanted to the permanent site the spring they are one year old. If held in the nursery, they should be carefully root-pruned in the spring or fall of the second year. The nut trees, oaks, and catalpa form long, fleshy taproots, about one-third of which should be cut off before the trees are set out in the field.

Where the winters are mild the seedlings will be sufficiently protected if the dirt is hilled up against them to a depth not to exceed six inches, just before the ground freezes. In more severe climates they should have a covering of straw, leaves, or moss to a depth of six inches to a foot.

In general it may be said that young trees can not be grown successfully without rather careful attention. Yet it is certain that seedlings can be grown in connection with the vegetable garden at only a slight expense of time and material, and by methods very similar to well-known garden practice. The cheapness of the young trees thus produced should enable the small landowner to plant much more extensively, and to realize a good profit by the protection afforded his buildings or crops or by the utilization of waste land for the production of wood material.

Planting Cultivated Fields to Forest.

The planting of fields which have been under cultivation for a long time, to forest, encounters problems not easily overcome. Especially is this true of the poorer soils in the broken sections where patch farming is most indulged. In such localities no crop rotation is observed, and a field is continuously devoted to the raising of one crop so long as it will produce at all, and afterwards cast out as waste. In such localities and upon such lands it is expected forestry will be most followed upon a large scale. Hence field planting will here be discussed from the two views, fields which possess good humus conditions and those which do not. So far as growth is concerned upon rich and poor soils, where humus abounds, it can not be asserted that the rate of growth and the sizes which the trees attain at maturity vary to any marked extent. Wherever good humus conditions exist splendid tree growth is found. The noticeable difference is the kind of trees found growing in certain soils. The adaptation of certain trees to specific soils can not be overlooked in planting and the best results obtained.

The following tabulation will indicate the soil adaptations of trees:

White oak, Quercus Alba, clay, sand upland.
Red oak, Quercus Rubra, moist, rich and porous.
Scarlet oak, Quercus Coccinea, low, rich, alluvial.
Pin oak, Quercus Palustris, low, rich, swampy.
Chestnut oak, Quercus Muhlenbergii, general.
Swamp white oak, Quercus Bicolor, low, wet, swamp.
Basket oak, Quercus Michauxii, low, wet, alluvial.
Burr oak, Quercus Macrocarpa, low, well drained.
Texan red oak, Quercus Texana, moist, rich.
Black oak, Quercus Veluntina, uplands.
Spanish oak, Quercus Digitata, dry, gravelly.
Barren oak, Quercus Marylandica, dry, sandy.
Willow oak, Quercus Phellos, sandy.
Shingle oak, Quercus Imbricaria, general, rich.
Swamp oak, Quercus Lyrata, borders of swamps.
Post oak, Quercus Minor, dry, sandy.
Chinquapin oak, Quercus Acuminata, any rich soil.
White elm, Ulmus Americana, general.

Hickory elm, Ulmus Racemosa, rich, low, wet clay.
Red elm, Ulmus Fulva, rich, low hillsides.
Black walnut, Juglans Nigra, rich, alluvial.
White walnut, Juglans Cinera, rich woodland.
Pecan, Hicoria Pecan, bottom, alluvial.
Swamp hickory, Hicoria Minima, wet and swamp.
Shellbark hickory, Hicoria Ovata, rich sand ridges.
Shellbark hickory, Hicoria Laciniona, moist, rich, alluvial.
White heart hickory, Hicoria Alba, rich upland.
Small-fruited hickory, Hicoria Microcarpa, rich woodlands.
Pignut hickory, Hicoria Glabra, dry hills.
Buckeye, Ascelus Glabra, rich, low soil.
Canoe birch, Betula Papyrifera, alluvial sand.
Red birch, Betula Nigra, low and wet.
Sweet birch, Betula Lenta, moist, alluvial.
White ash, Fraxinus Americana, any rich soil.
Green ash, Fraxinus Lanceolata, low, rich bottom.
Blue ash, Fraxinus Quadrangulata, hills and ridges.
Black ash, Fraxinus Nigra, general.
Yellow poplar, Liriodendron Tulipifera, rich.
Linden, Tilia Americana, rich.
Sugar maple, Acer Sachernium, rich upland.
Black sugar maple, Acer Nigrum, rich lowland.
Red maple, Acer Rubrum, low, wet.
Black locust, Robina Pseudacacia, rich, low, sandy.
Honey locust, Gleditsia Triacanthos, low, rich.
Wild plum, Prunus Americana, low, rich.
Wild black cherry, Prunus Serotina, rich highland.
Persimmon, Diospyros Virginiana, abandoned.
Flowering dogwood, Cornus Florida, rich upland.
Hardy catalpa, Catalpa Speciosa, rich, general.
Sassafras, Sassafras Officinale, upland, clay.
Hackberry, Celtis Occindentalis, upper river, dry.
Red mulberry, Morus Rubra, rich bottom.
Sycamore, Platanus Occidentalis, wet, general.
Ironwood, Ostrya Virginica, dry, sand ridges.
Chestnut, Castenea Sativa, upland, rich.
Beech, Fagus Americana, rich upland.
Cottonwood, Populus Deltoides, low, wet.
White pine, Pinus Strobis, general hilly.
Yellow pine, Pinus Mitus, low swamp.
Bald cypress, Taxodium Distichum, swamps.
Tamarack, Larix Americana, swamps.
Red cedar, Junipera Virginiana, hilly gravel.

The planting of trees in pure or mixed relations is another matter to be considered. If the area to be forested consists of the same soil then pure planting may be consistently done, but if a variation of soils occur then a mixed planting is preferable. A

mixed planting may be done in two ways, by planting in confusion or by planting in groups. In the former the trees or seeds, as the case may be, are alternated in mixture throughout the area, while in the latter the different species are planted in pure groups or patches throughout the area, according to the different areas of soil constituting the area planted and in the relationship of adaptability of tree and soil.

There are differing opinions expressed regarding the success of pure and mixed plantings. It is held by some that pure plantings are the most successful, while others claim that mixed plantings are the best. If there be truths in the following statements: Specific plants require specific soil elements for their life and development; the soil contains many elements suited to the life and development of the multiplied species of plant life thereon; the continued growing of one form of plant life upon a soil will exhaust its substance; plants growing in confusion have a sustaining effect upon each other and upon the soil producing them; all resultant plant life is the culmination of the survival of the fittest; that all plant life is nourished by means of its leaves with which it extracts the carbon-dioxide from the atmosphere and in the sunlight transforms it into starch, upon which the tree lives and is fed, and the only substances taken from the soil by the roots of plants are water and mineral substances, which are in no way foods, then both claimants have grounds for their arguments, and the seeker for wisdom in such matters must go to nature's teachings and see how she performs them. Since nature grows them in confusion it surely is wisdom to example her. Select the best commercial species and plant them in mixture agreeable with the soil variation and there can be no question of the wisdom of the action at least.

CULTIVATION.

The cultivation of planted trees in open fields is simple. If the trees are planted in rows cultivation may be performed by plowing in the same manner as agricultural crops are tended. If they are not so planted they can be cultivated by hoeing. At the Experimental Station of Forestry both methods are employed. Both are equally successful. The amount of cultivation given them need not be extensive. Only such attention as will insure

the young trees from injury by weed and other wild forms of plant life which, if unchecked, would overcome them. The points to be well considered in all cultivation is to not peel and otherwise injure the young trees. The scraping of the bark from the young trees by the whippletree or plow, the bending over and breaking the fiber, the splitting of the limbs from the trunk or the breaking out of the top bud are things which should be avoided. Any and all of these will tend to destroy the future possibilities of the tree to attain its best commercial development. No stock should be permitted to graze or fire to burn through young trees. (See "Field Cultivation" at Forest Reservation of this Report.)

Forestry—Its Influence upon Animal and Plant Distribution.

BY PROF. STANLEY COULTER.

The distribution of plants and animals over the surface of the earth is no longer thought to be a matter of chance. Indeed, it is known to be determined by certain laws, some of which have been fairly well made out, some of which still elude us. In a general way it may be said that the physical environment determines the plant and animal life, for this environment must meet the vital necessities of the forms which it contains. It follows that any marked change in surface conditions will change in an equally marked way the life forms inhabiting a given region, for with the change in conditions there comes a change in the life possibilities of the region.

If the Kankakee marshes be drained and brought under cultivation it is very plain that great changes will take place in the plant and animal life of that large area. The ducks and geese, the lesser water birds, the myriad fish of the bayous and streams will all disappear. Some will perish utterly, others will find new homes in which their needs are met. Among the plants the cat-tails and rushes, the coarse sedges and marsh grass, the flags and water-lilies, will go, their places being taken by forms able to meet the changed conditions. This is perhaps an extreme case, but it is one which most of us will live to see, the supplanting of one series of plant and animal forms by another series sharply and definitely distinct from the first. Whether this change will, in the long run, be advantageous, time alone can prove. The illustration is merely used to show that in a very definite way the physical conditions of a region determine the plants and animals of that region.

In the desire to secure agricultural areas men have thought little of the effect of the surface changes they were working upon the life forms surrounding them. Nature through long centuries had worked out a balance of life, which man without thought has over-

thrown in a few years. In our own area these changes have in the main been of two kinds; changes resulting from drainage operations and changes resulting from clearing of forest areas. The life changes resulting from the first are perhaps the more evident, but it is doubtful if they are the more important and far reaching.

When a forest is cut away the most evident fact is the admission of the sunlight to areas hitherto shaded. The result of this change in light condition is, that a series of shade tolerant plants either die immediately or maintain a feeble existence for a few seasons and then disappear. Many of these plants have been put to no direct use by man and yet they have had their part to play in the economy of nature. Few of us can name the mosses and ferns and other forms found in forest areas, and yet we know that when they disappear the thirsty air draws the moisture from the soil more fiercely and rapidly than when their protecting cover guarded the water of the soil, which is, after all, its real wealth. Not only do these lowlier plants require shade, but many of our trees are intolerant of light and only come to their full development when they can receive the shade of other forms. Thus the possibility of the reproduction of many valuable tree forms, except as the result of careful methods is absolutely precluded. It is not necessary to give examples of changes resulting from this altered light condition, for every one reading this paragraph will recall plant after plant, formerly common, which has now utterly disappeared from the regions in which it formerly occurred.

Another result of forest clearing is a change in the capacity of the soil for taking up and holding moisture. Practically the same amount of rain falls from year to year, but as the result of the clearing of the forests more of the rain goes as "surface run off," less is taken up by the soil. Then, too, this less amount is held less tenaciously, for unprotected by the shade of the forest the earth lies exposed to the fierce rays of the sun, and unguarded by the forest floor, the soil is compelled to give up its moisture. It is not so much the amount of moisture precipitated that determines the plant life of any given area as the way in which that moisture is conserved and distributed. No profounder change in soil moisture conditions can be imagined than that resulting from the de-

struction of large forest areas. As a result of this change in condition profound changes in plant life have been brought about, and hundreds of forms have disappeared from our flora.

It is not necessary to give specific instances of change. It is evident that such marked changes in surface conditions must have worked great changes in the plant life of the State, changes still going on, and indicated not only by the disappearance of one familiar form, but equally by the appearance and spread of new forms which are taking the places thus left vacant. Almost invariably these new forms are weeds and their introduction means an increase of labor and lessening of profit.

As a rule, however, these plants which have disappeared because of changed conditions, have been replaced by economic forms, our food and forage plants, which thrive only under these new conditions, and were the changes resulting from the clearing away of our forests thus limited, it would be a change from the useless to the useful, and any loss would be more than compensated for by the rich returns.

This would be true if the story ended here, but life forms are not only intimately related to their surroundings, they are related with equal intimacy to each other. These inter-relations and inter-dependences are so close and so far-reaching that it is almost impossible to affect one form without more or less definitely affecting all. The dependence of animals upon plants is, after all, the most vital, since plants and plants alone can furnish food to animals. The existence of animals in any given region is primarily dependent upon the food supply, and any change in the quantity or quality of this food supply has a quick response in the animal life of the area. Thus when the plants of a region change the animals necessarily change, and since the relation of animal forms to man is more evident than that of plants, we may catch more clearly some idea of the importance and significance of the changes wrought by the wide destruction of forest areas and incidentally gain some idea of the possible utility of judicious reforestation. The forest is the home of many animal forms. Birds nest there, many of the smaller animals make their homes and find their food in it, and in its depths the larger forms have shelter or build their lairs. But man desires the land for tillage and in a year the for-

ests are gone and with them the life forms dependent upon their presence. The bear, the wolves and foxes for the most part, the deer, have disappeared, and even the squirrels and the raccoon are rapidly lessening in numbers. What birds have gone we can scarcely say. We know the Carolina parakeet and the Passenger pigeon have completely left us, that the ivory-billed woodpecker no longer drums in our woods, and that the number of individuals of the wood-loving forms that still remain is greatly lessened. Shelter and food gone, we can not expect their return. It is probable that we shall never feel the need of the presence of the larger mammals, but many of the smaller mammals, and especially the birds, have such close relations to agriculture and horticulture that anything which will increase their numbers will prove of great and immediate economic value.

The birds in the economy of nature hold in check two of the greatest enemies of the agriculturist, noxious insects and weeds. It has been estimated that if insect-eating birds were destroyed there would, within a single year, be a noxious insect for every square inch of territory from the Atlantic to the Pacific. Our father's father did not use sprays or other devices to guard against noxious insects. He trusted to nature's check, the birds, and the birds did their perfect work and the balance of life was maintained. Today, with the homes of birds destroyed, we are at all times practically at the mercy of the insects, or at best fight them by doubtful and cumberous methods. Years ago the codlin moth was practically unknown, and the sound apple was the rule and not the exception. But then blue birds and orioles, creepers and so-called sapsuckers, and a host of other forms, were doing their work, and a part of it was the destruction of the codlin moth. The legislature of Pennsylvania once placed a bounty on hawks and owls, because of their destruction of poultry. In one year the State paid out nearly $50,000 in bounties. For the next few years the crops of cereals in Pennsylvania failed and when the cause of the failure was sought it was found to be the rapid increase in the number of field mice and other grain-destroying animals, and this increase was due to the wholesale destruction of hawks and owls. The birds were nature's check for the field mice. That biological experiment cost the farmers of Pennsylvania something over four millions of dollars in crop losses.

It is, of course, impossible to restore the forests, but woodlots on farms, or the forestation of a few acres, will serve in a large measure to increase the number of these effective workers for man. If in existing woodlots plant forms furnishing bird food were introduced it would mean much. If along our roadways hedges were planted, if for no other purpose than to furnish resting places for birds, it would pay in dollars and cents. The changes in animal life resulting from a destruction of forests may be summarized as a disturbance of the balance of life by a reduction in the number of forms useful to man and a consequent increase in the number of forms injurious to man.

In the matter of protection against weeds the work of birds is scarcely less evident. For example, birds of the sparrow kind (not the English sparrow) feed almost wholly upon weed seeds. It is estimated that the weed seeds destroyed in Iowa by birds of the sparrow family amounted to 900 tons annually. Not the sparrow only, but many other forms of birds are engaged in this beneficent work, and with their disappearance or reduction in numbers the weed problem is increased.

Quite apart from the value of the wood material to be derived from woodlots or the forestation of unused areas, no farmer can afford to be without a tract of woodland if for no other reason than to give shelter and food to the animal forms which hold in check noxious insects and weeds. Until we know more accurately the life history of our various plant and animal forms we can not determine with accuracy the significance of the life changes that have resulted from the clearing away of our forests, but we do know that such serious changes in life disturbance of the balance of life works equally serious changes in life relations, and that in the main these changes are harmful rather than helpful! If by judicious forethought, if by careful methods in the utilization of waste areas, we can in some measure re-establish these relations we will have done much to lessen our labor and add to the wealth of the State.

Forest Planting in Indiana.

BENJ. W. DOUGLASS.

Few States excelled Indiana in the grandeur and extent, as well as the quality of their original forests. Practically the entire State was covered with a fine growth of deciduous trees whose wood was adapted to all of the uses of the pioneer and farmer, as well as to those of the manufacturer who followed them. From the viewpoint of the early settlers the forest was an obstacle in the path of progress, and we can easily imagine that with them our finest trees were as a curse with which they had to struggle. They needed corn more than they needed timber, and what to us seem wasteful methods were to them only measures of necessity, rendered imperative by the severity of their struggle for existence. The available supply of timber was, for many years, thought to be inexhaustable, but with the advent of the steam railroad and the rapid development of our industrial life we have seen the matchless forests not only of Indiana, but of America, dwindle away until the future timber supply has become a national problem. It was a demand for a solution of this problem that created and fostered the Forest Service of the United States Government and the forest departments of the various States. And it was the desire to assist in solving the problem that has led many scientific men into the profession of forestry, a profession founded upon the great fact that wood is an indispensable commodity, not only in our everyday life, but in the everyday lives of all who are to follow us.

To a large extent practical and experimental work in forestry has been left to the Government and until recent years only comparatively few individuals have done anything of any great moment.

However, the need of forest planting has been felt in many Indiana localities within the past half dozen years and it is the purpose of this report to present some information relative to what has been done and to draw such conclusions and make suggestions

Typical trunk form of the Catalpa Speciosa when grown in the open field. Never cut back nor trimmed.

as may be deemed advisable to secure the best results from the forest planting of the future.

Most of the larger tree plantations of the State have been inspected by the writer and detailed accounts of some of them will be given later.

Probably no other tree has been so widely planted as the catalpa and probably none has produced such disappointing results. Un-

Catalpa Bignonioides in open field. Typical low spreading shape.

fortunately for the growers of trees there are two species of catalpa, a good species and a worthless one—and very few of the good kind were planted by the earlier planters. Of later plantings not so many errors were made. The Catalpa speciosa, Warder, is a native forest tree whose original habitat did not extend far from the valley of the lower Wabash River. In that restricted territory the catalpa was a famous wood and used by the early settlers for many purposes. So eagerly was it sought that, like

Trunk of Catalpa Bignonioides. Notice the thin, scaly bark.

the white oak and the black walnut, it has been practically exterminated. The fast growing character of the tree and the durable quality of its wood recommended it to aboriculturists many years ago and its extensive planting has since been widely advocated.

At about the time when Catalpa speciosa was first being advised

Trunk of Catalpa Speciosa. Notice the dark rough bark.

for commercial tree planting, another form of the tree had been introduced from the South. This tree, the Catalpa bignonioides, Walt., was a purely ornamental species, making a low-spreading tree and boasting no value as a timber producer. Partly through cross-pollenization and partly through the ignorance of seed dealers and nurserymen, this Southern species and its hybrids have been

extensively planted. It is an unfortunate condition, for which it is very hard to fix the blame. It is impossible to tell the valuable catalpa from the worthless kind until the trees blossom and form seed pods. Again, it is not a sure method to grow trees from seed taken from a known specimen of C. speciosa, for no one can say that such seed is not "crossed" with pollen from a bignonioides flower. All the members of the catalpa family are prone to hybridize, that is to "cross" species, thereby creating departures from the type. In this they are analogous to the melon family. Seed taken from a fine watermelon may produce very inferior fruit, due to the fact that a pumpkin vine grew in the neighborhood of the seed plants—and yet the melon from which the seed was taken appeared prime. This uncertainty of securing pure catalpa speciosa stock makes the planting of this tree a very uncertain venture and one that can not, consistently, be encouraged. The distinguishing characters of the two trees may be summed up as follows:

Catalpa speciosa; tall growing, persistent main stem; bark rough; seed pods few, 18 inches or more in length and ¾ inch in diameter.

Catalpa bignonioides: low growing, much branched; thin bark; scaly; seed pods many, 12 inches or more in length and ⅜ inch in diameter.

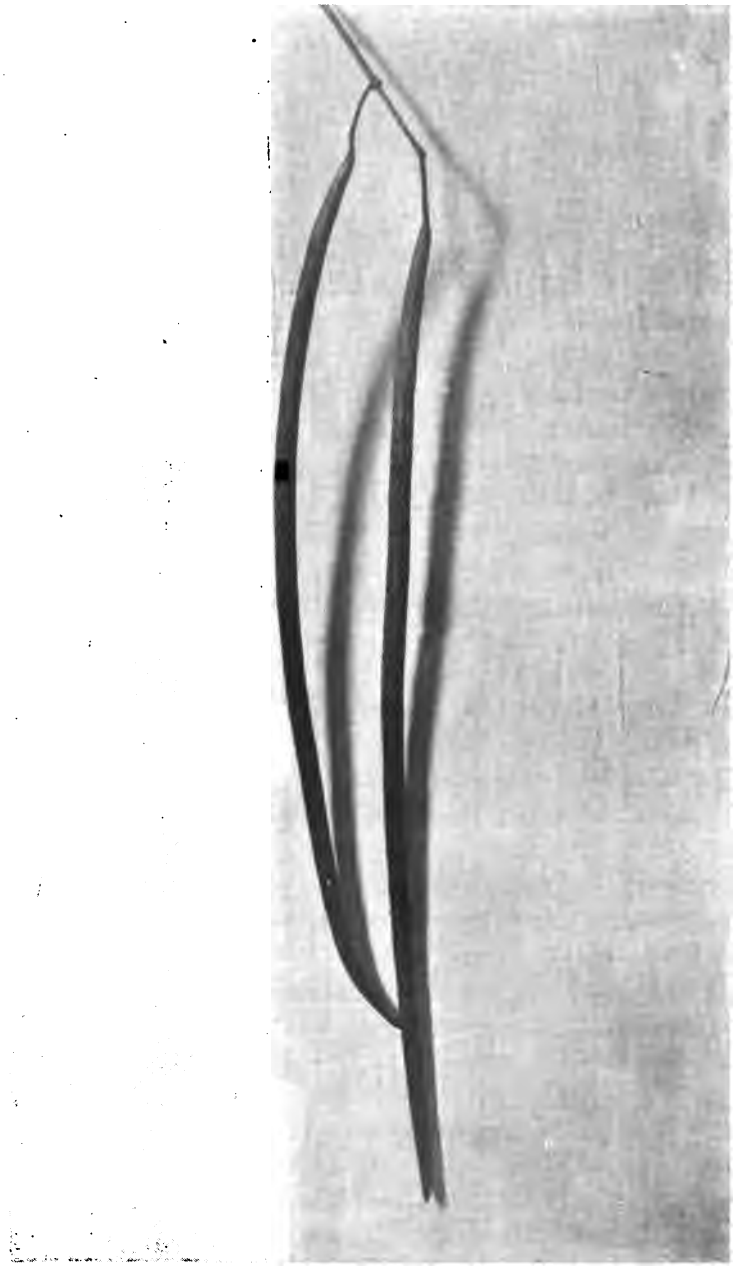
Various systems of planting have been used, in most of which the trees have been placed too close together. Close planting will produce tall straight trees, but they will be slow to take on diameter. It seems best to plant close in the rows and to put the rows farther apart. The best showing of catalpa that we have seen was planted 3 feet by 10 feet, the rows running north and south. Closer planting will produce slower growth and be harder to cultivate and much harder to harvest when it reaches a marketable size. The claim has been made that no catalpa tree will grow tall and straight unless it was planted with others, close together. This is absolutely a mistake, induced doubtless by a study of the Catalpa bignonioides. The Catalpa speciosa will make a tall straight tree even when grown in the open fields, and without any cutting back or pruning, but, as we have said before, it is impossible to tell the variety of catalpa trees until they have produced seed.

Next to the catalpa, the most widely planted tree is the black locust, Robinia Pseudacacia L. This tree grew native in the

southern part of Indiana and there are still some fine groves along the Ohio River. The wood is strong and hard and is very durable in the ground, and it is its value for posts and ties that has led to its extensive planting. The great objection to locust for commercial planting is that it is subject to the locust borer, cyllene robiniæ, a beetle, the larva of which burrows through the wood, rendering it useless for any purpose and often resulting in the death of the tree. In the Schramm plantation in Hancock county 25 per cent. of the trees are already killed and practically all of the remainder are affected.

At a number of plantations experiments have been made looking to better methods of cultivation of the locust. The best growth of course is made when there is a good moisture supply in the soil. A condition of drought will check the growth of trees just as surely as it will retard any other form of vegetation. Any precaution that tends to retain the moisture in the soil will aid the continued growth of the tree and by mulching the ground before the early summer rains are over the growth of the tree can be prolonged far into the summer. Shallow cultivation of the soil (not over two inches deep) just after a rain will have the same effect as a mulch, as the broken surface soil creates a dead air space that prevents evaporation of the deep moisture.

The remark is sometimes made that locust trees will grow on any soil no matter how poor, because they "fertilize" the ground. It is true that the locust belongs to the same family as the clover and possesses the same power of fixing nitrogen from the air and making it available in the soil—further than this *no fertilization takes place,* because nothing is added to the soil that was not there in the first place. It is a common fallacy that soil which is fit for no other purpose will grow trees. Trees, like any other form of plant life, obey the universal laws which govern the growth of vegetation. A tree, or any other plant, may be considered as a factory in which the raw materials, water (from the soil), oxygen and carbon (in the form of carbon dioxide from the air), are manufactured into more complex substances, such as sugar, starch and cellulose. (Wood is largely cellulose.) Before this plant factory can manufacture any of these complex substances it must have its machinery in good working order, and this necessitates the presence of certain chemical elements obtainable only from the soil.

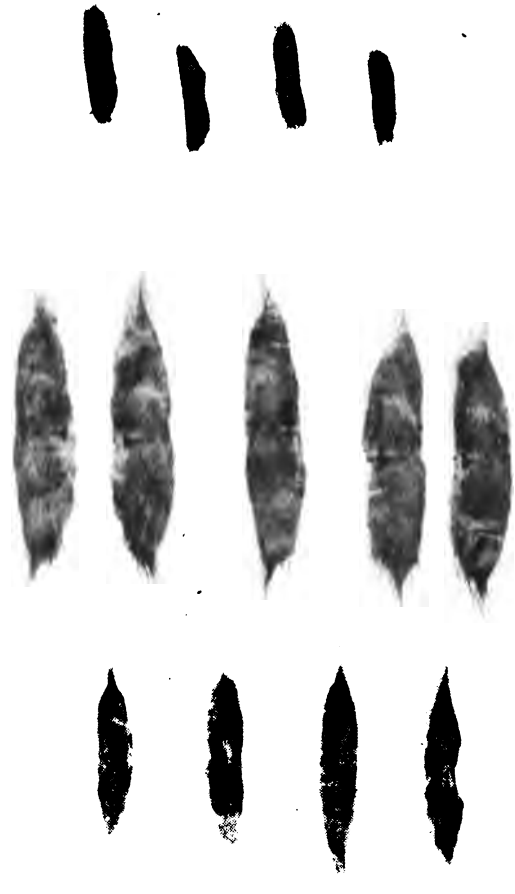


Seed pods of Catalpa Speciosa. It can not always be taken that there are but two pods in a cluster.

The machinery which does the work is protoplasm, the raw materials are carbon, hydrogen and oxygen, and light is the motive power. Good plant growth can not be expected under any condition in which any of these factors are wanting. Soil which is lacking in the "machine" elements, that is the elements necessary

Seed pods of Catalpa Bignonioides. Notice the large number of pods in the cluster.

to the proper formation of protoplasm, is certainly not adapted to growing trees or any other forms of plants. Some of the so-called "bad" soils of the hilly part of southern Indiana are unsuited for ordinary farm crops, but will answer admirably for tree plantations. This may seem contradictory, but it is not. The soil on



Seeds of different species of catalpa. Upper row—Japanese variety
Middle row—Catalpa Speciosa variety. Lower row—
Catalpa Bignonioides variety.

the rough slopes is shallow, but what there is of it is good; the objection to using it for annual farm crops is that under such conditions all of the good soil is soon washed away into the valleys, leaving the slopes rocky and barren. Under forest conditions the soil is held in position and will produce a normal crop of trees. Of course any knob country that has been cleared and used for farm purposes for any length of time will probably have become unfit for any agricultural purpose.

The black walnut, Juglans nigra L., has not had the attention from tree growers that it deserves. It is a fast growing tree and will form a tall, straight trunk. Where quick returns are desired on a plantation the trees can be cut for fence posts nearly as soon as any of the other trees grown for these purposes. The black walnut, however, requires a better soil than some other trees. This is perhaps due to the fact that more valuable soil elements are actually built into the wood than in other varieties. The ailanthus, for instance, is almost able to grow where it can get air and water—its wood is worthless. The black walnut as a post or tie timber is equal to white oak and sells with that oak on the market.

Our study of the pine as a commercial plantation tree has been limited, owing to the fact that pine plantings in the State have been largely for landscape purposes, and very little data is obtainable relative to them. The native pine in southern Indiana is the yellow pine, Pinus echinata Mill. Where they have been planted together the white pine, Pinus strobus L., has made a better growth than the native species.

Of all the trees that have been planted for commercial purposes, we know of none that can equal the chestnut, Castanea dentata Borkh. In rate of growth it excels any of the other trees in this list; its upright habit makes it suitable for telephone poles; it is very durable in the soil; it has few enemies; and there is no mistaking its young form for any other species. More will be said of it in connection with the Fairview plantation.

PLANTATIONS.

The Fairview plantation is deserving of considerable attention. It is a planting of several thousand trees, mostly catalpa and chestnut, and gives an excellent opportunity to compare the two trees. The trees were planted by Mr. William Mustard on a portion of his farm north of Indianapolis, in the spring of 1885. Several

thousand trees were put out on a tract of broken ground that was inclined to wash badly. The soil on the higher slopes is poor. The lower land is better and has produced better trees.

The trees were all one-year-old seedlings when planted and were about a foot high. They were planted in rows about ten feet apart and spaced about three feet apart in the rows. They had three years' cultivation as for corn, and have since had no attention given them. They were not "cut back," as has been advised for catalpa growing, but in spite of that they have made very straight trunks. We are unable to find any seed pods on any of these trees, but their upright habit of growth and lateness of seed bearing indicate a tendency to Catalpa speciosa. The patch recently changed hands and the present owners are cutting some of the trees for posts. The cutting is being done in a crude and wasteful way, so that the greatest value from the planting will not be realized.

The chestnut trees were planted at the same time as the catalpa and have far outstripped them in the race. In some cases the catalpa and chestnut were planted side by side in the same row and give an excellent opportunity to compare their relative rate of growth. It is reported that many of the chestnut trees died the first season, but as no good reason has been assigned for it, would suggest that the failure was due to some local soil or weather condition that was unfavorable to the young seedlings. There is no report of any of the chestnuts dying after the first year.

One cultural precaution that must be taken with both the catalpa and chestnut is the removal of the lower branches. Unless this is done the branch rots into the trunk and ultimately may cause the death of the tree.

Quite a lot of spruce was planted at the same time as the other stuff on the Fairview plantation, but it has not reached a marketable size.

This is the only plantation that is old enough to furnish a basis on which to estimate the commercial value of such work, but there is no data at hand relative to what it has cost to develop the plantation. Most of the work was simply incidental to the farm work and the chief expense has been the idleness of the land while the trees were growing. In this case the land could not have been used for any farm purpose, so that the loss of crops can hardly be

considered. The value of the land has increased to such an extent as to make the plantation a good investment from a real estate standpoint, and land has been utilized that under farm conditions would have soon been cut and gullied with each succeeding rainstorm till it would have been worthless for any purpose. From a rough estimate we can conclude that the marketable trees on the Fairview plantation will pay the first cost of the land, which was high, all expenses of planting and cultivation and still afford a fair profit on the investment.

The largest locust planting in the State is that of J. E. Leavitt, at Greyford, in Jennings County. It consists of 130 acres of poor land more or less hilly. Most of the trees were eighteen inches high when set out in the spring and fall of 1904. The trees will now average about eight feet in height, but many of them are in need of trimming. They have been cultivated since planting, and as a result make a good growth well into the summer. This late summer growth is tender and has a tendency to die back after a severe winter. This is true of all plantations that have been excessively cultivated. As a whole the plantation is in good condition, but is too young to warrant any estimate as to its value as an investment. It ought to pay well, as the cost of the land was low, only $20 per acre. The most discouraging thing is the presence of the inevitable locust borer, though they are not as bad as in some other patches we have visited.

Mr. Q. A. Meyers, of Logansport, has planted 15,000 locust trees on seven acres of poor sandy soil on his farm at Lake Cicott, Indiana. The sprouts were twelve to eighteen inches high when they were planted in the spring of 1902. They were never cultivated after planting, and the total expense outside of the land consideration has not exceeded $40. The trees were planted about four feet apart each way and it was expected that they would trim themselves. They have not come up to expectations in this respect, for the trees are badly in need of trimming. Some borers are present.

Arthur Buchanan has planted several acres of locust northeast of Lake Cicott. His plantation is similar to the Meyers patch, except that the ground is more broken. In both of these plantations there has been very little winter killing, owing to the fact

that the trees make their growth early in the year and by fall have seasoned so that they can withstand the cold.

Gustave Schramm has done considerable planting at his farm southeast of Indianapolis, in Hancock County. One patch of locust was planted in 1902 and is now in bad shape from the borers. A second planting made one year later is not so badly infected and is much cleaner. Both of these plantings are shown in the cuts. Mr. Schramm has also planted some catalpa, but apparently of the wrong species. Some of the walnut trees put out about ten years ago are in nice shape and have made a good growth.

Mr. August Langenberger, whose farm joins Mr. Schramm's, has an excellent planting of locust. In fact, it is the best lot of locust trees that we have seen in the State. The eighteen-inch sprouts were planted in the spring of 1902 on a piece of cleared land lying northeast of a heavy woods. These woods have formed a windbreak to the locust and have no doubt contributed to its good growth. The trees were planted in rows ten feet apart and are three feet apart in the row. In spite of the wide rows the trees have made a fine growth and have no tendency to branch low. The soil is a rich black loam. The effect of the borers is not very noticeable; in fact, most of the trees seem free from the pests. As a result of the wide planting the trees have made a rapid growth, and some of them are four inches in diameter and have trunk enough to cut two fence posts. They were not cultivated after the first year.

There are a number of smaller locust plantings over the State, but for the most part they are too small or too young to warrant an account at this time.

As stated elsewhere, the pine tree planting in this State has been largely confined to landscape work. At the farm now owned by the Epitomist, an agricultural paper, at Spencer, Ind., there has been a rather large planting of white and yellow pine. While we have been unable to get any data relative to when this stuff was set out, the indications are that it is at least thirty years old. The ground occupied is a steep hill slope, soil thin, limestone outcrop. The white pine has made a growth superior to the yellow pine with which it was planted.

At Spencer there has been some chestnut planted on top of the hill on which the pines are growing. The presumption is that it was planted at the same time as the pine. Although the chestnut has the most exposed position and the poorest soil, it greatly exceeds the pine in size.

It is a common impression that chestnut trees grow low and spreading, like an apple tree. Perhaps they do—in the open field few trees do not—but when planted closely the chestnut makes a trunk as straight as a pine. They will make excellent telephone poles.

The natural range of the chestnut did not extend far above the southern part of Indiana, but it has grown successfully as far north as Michigan, showing that it will make a commercial tree over practically the whole of this State, and all things considered, it seems to be the most practical tree to grow for quick returns, and the near future will doubtless see its extensive planting in many localities.

Note.—The following criticisms are offered by the board to the above report:

The discussion of the distance at which catalpa trees should be planted merits criticism. The distances, ten feet by three feet apart, are too great to produce natural trimming, which should be made to occur at as early a date as the trees can be made to shade the lower limbs, and thus cause them to become dead and fall away. If the trees are planted at the distance given in the discussion they get too much sunlight, and numerous limbs grow from the trunks of the trees as shown in the cut therewith. Not enough shade is produced upon them to cause the dying of the limbs until they become large, and when they do become dead they cling to the trunk of the tree so long that they produce the effect of trunk injury shown by a cut accompanying the discussion.

It will be more satisfactory to plant the trees closely, and thus cause self-shading and the killing of the limbs when small, and which will soon fall away and no trunk injury will occur. The best distances are two by six feet apart or five feet apart each way, and when the trees begin to crowd each other they can be thinned out. The boles can then expand and the boles formed because of close planting will be long, smooth and much straighter than will

occur from the other plan. Even the cutting and casting away of half the trees planted at the beginning six years afterward will not be a loss in the crop at harvest time, because of the quantity and quality of product secured because and resulting from the early close planting.

Also the discussion given concerning the cutting back of the catalpa after planting and permitting to grow for a few years must be reconsidered. Much straighter trees and better results will accrue if the cutting back plan is followed. There is too much evidence of this to be doubted.

The trimming of black locust is also another discussion deserving of criticism. It is not a good thing to prune locust trees. They should be planted at distances of two by six feet, or at distances regular four and five feet apart. The locust, owing to its thinness of foliage, thereby admitting the sun's light, will stand closer planting than the catalpa, and it is more necessary in order to secure the shade for self-pruning. The truth of this has been made apparent by suggestions made to Mr. Q. A. Meyers by Mr. Douglass at the time of visiting his planting and instructing that his trees needed pruning. Mr. Meyers has investigated his planting and finds the numerous limbs upon the trunks of his trees all dead and so nearly ready to drop away from the trunks of the trees that with a club he could knock them off as easily as brushing icicles from the eaves of a building during a thaw. Close planting to produce early shading and self-pruning will form taller and smoother boles, and later thinning will give plenty of room for bole expansion in growth. The locust borers will also not be so plentiful.

These suggestions of criticism are made to give the Board's views concerning these questions, and also to permit of Mr. Douglass' expression on the same for the public's consideration.

No. 1.

Locust trees in the same row with No. 2. These trees had a mulch of hay placed around them early in the summer. This kept the moisture in the ground and as a result the trees continued their growth well into the fall.

Locust from the Leavitt plantation.

No. 2.

Locust trees in the same row with No. 1. These trees have had the soil exposed to the sun and have made all of their growth early in the year.

Young locust sprout trimmed to straighten the trunk. When the tree dies back in the winter the terminal bud is killed and the new growth often starts from two sides and creates a "fork." In the cut shown, one side of the fork had been cut away, leaving the other side to carry the growth upward.

Locusts in the Schramm plantation. The tree the man has hold of is two and one half inches in diameter. The trees are about three years old.

Locust trees growing on the Schramm plantation. Twenty-five per cent. of these trees are eaten off by borers.

Locust borer knot, cut open to show the channel cut by the insect.

U of M

Locust borer has weakened the tree so that it broke over in a heavy wind storm.

Typical locust borer knot. A weak place in the tree that will be broken in the first heavy wind.

Walnut trees on the Schramm plantation. These trees are about six years old.

Spontaneous growth of black walnut on open field.

American Chestnut tree growing along with Catalpa at the Fairview plantation, showing the American Chestnut to be the faster growth.

A view of Chestnut growing on the Fairview plantation and showing the bole formation when planted closely.

Catalpa trees on the Fairview plantation. These trees were planted too far apart to produce self-pruning by shading and killing the lower limbs.

Spruce planting on the Fairview plantation.

Wasteful methods of cutting on the Fairview plantation. The larger part of the trunk of the tree has been taken but the top, which will make a good post, has been left.

A view of second crop of Locust springing from the stumps after first trees were cut, and showing the multiplied product of the second crop.

White pine planting about thirty years old at Spencer, Indiana.

Mixed conifer planting at Spencer, Indiana. Planted for **landscape purposes, but showing that this kind of stuff will do well on relatively poor lands.**

White Pine on the left. Yellow Pine on the right. Both planted at the same time.

View of a four months' old Catalpa Speciosa sprout on the Senator Parks' plantation, Bourbon, Ind., from a two-year-old stump, after cutting back.

View of a two-year-old Catalpa Speciosa sprout on the Senator Parks' plantation, Bourbon, Ind. This sprout is from a stump cut back two years old.

The Hackberry—A Neglected Tree.

BY BENJ. W. DOUGLASS.

It was not until the cypress lands of the South had yielded the best of their cypress timber that lumbermen turned their attention to the heavy stands of tupelo, which grew with the cypress and which had been neglected because of a popular prejudice against it. Then, when the cypress was practically exhausted and the demand for wood became great enough, some one with an investigating spirit began to try to use the so-called worthless tupelo. At first it was found to be almost impossible to dry the wood without a great loss from curling and checking. Many experiments, however, demonstrated that the difficulty was not alone with the wood, but with the method of handling it. A little more care in handling it, and it was found to be easily dried and did not warp nor check, and soon plenty of uses were found for it in the manufacture of many articles.

When the hardwood forests of Indiana were cut over for their timber, practically all of the hackberry was left, and today in some localities we find that it constitutes the principal large tree of our remaining groves. In Indiana the hackberry, Celtis occidentalis, grows to be a large tree, while in the east it is often a mere shrub. With us there is no tree that makes a better trunk or that will cut more board feet of lumber to the tree than this same neglected remnant of the primitive forests. It is a fast-growing tree, and we have previously called attention to its value as a shade tree in city streets.

Such trees grown in a close plantation will make growth greater than any of the trees now planted for commercial purposes, though the returns from such a plantation will not come so soon, owing to the fact that the trees can not be used for fence posts, but must be allowed to stand long enough to make a large material for manufacturing purposes.

During the past season we have been investigating the standing of the hackberry as a timber and trying to learn just why it has

not been used. The claim is made that it is not a durable wood in the ground, and this claim seems to be well founded. Mill men have said that the wood warps badly in drying, but we are inclined to believe that this opinion is founded on the behavior of some other wood, as the man who made the statement also said that the wood of the hackberry was about the whitest wood that they had ever had any experience with. There are many woods that are whiter. In the log the sap wood, of which there is a large proportion, is a light greenish, the heart wood is much darker and considerably harder. Both the sap wood and the heart wood is coarse-grained, but hard and capable of taking a good polish.

The large quantities of hackberry still standing in the State should warrant a very thorough investigation of its qualities, for the need of a suitable wood for the cheaper grades of furniture and other important manufacturing interests calls for an immediate supply of cheap material.

As a type of the trees standing in the woods north of Indianapolis we would call attention to cut No. 1. This tree stands now in a real estate addition that is being sold off in city lots. It measures sixty feet to the first branch and will cut five twelve-foot logs, the smallest of which will measure eighteen inches. By a conservative estimate this tree will cut 1,900 board feet of prime lumber and scores of others fully as large can be found in every woods in the region.

The only insect enemy that we have been able to find on the hackberry is one that does no very great damage to the tree. It is the common hackberry gall, and its chief effect seems to be to produce dense clusters of twigs on the smaller branches.

We had intended presenting the results of some experiments on the hackberry timber, but were not able to secure suitable material in time to get results for this report. However, we have planned to work out a series of elaborate experiments on the wood to try to determine the best use of it, and will complete the work as outlined in time for the next annual report of this department.

Characteristic trunk of the Hackberry. The part shown will cut 300 board feet of first grade timber.

Hackberry tree in woods near Indianapolis. Shows the type of tree still to be found in considerable numbers.

Statistical Circulars

PUBLISHED BY DIVISION OF FORESTRY OF U. S. AGRICULTURAL DEPARTMENT, WASHINGTON, D. C., 1905.

Wood Used for Pulp in 1905.

INTRODUCTION.

The following tables of the quantity and value of wood used for pulp are compiled from reports made direct to the Forest Service by wood-pulp manufacturers. Acknowledgment is made to these manufacturers for their cordial and efficient co-operation. The number who neglected to report is less than 5 per cent.

The amount of wood used for pulp is small in comparison to the total lumber production, being about 4 per cent. of the annual production of lumber, and 3 per cent. of the value. Yet the wood-pulp industry is of much importance and has developed rapidly. According to the census of 1900 there was during the decade 1890-1900 an increase of more than 17 per cent. in the number of establishments and of more than 86 per cent. in the capital invested. The figures apply to pulp and paper mills combined, but it is safe to assume that the ratio of increase holds good if applied to pulp mills alone. A preliminary bulletin recently issued by the Bureau of the Census shows that from 1899 to 1904 there was no increase in the number of establishments, but that the capital invested increased 66 per cent. during that time.

TABLE I.—*Wood used and pulp produced in 1905.*

State.	Companies.	Wood used.		Pulp produced.
		Amount.	Value.	
	Number.	*Cords.*		*1,000 pounds.*
New York	60	1,301,986	$8,137,412	1,964,626
Maine	18	501,807	2,950,625	646,024
Wisconsin	30	382,471	1,686,697	481,314
New Hampshire	6	239,700	1,257,306	257,795
Pennsylvania	11	250,826	1,158,816	246,744
Michigan	8	109,764	475,278	126,551
West Virginia	4	96,357	497,202	99,718
Virginia	3	89,540	492,470	89,299
Ohio	3	54,000	274,320	58,100
Minnesota	3	31,802	121,801	49,484
Vermont	7	22,271	122,490	40,415
Massachusetts	4	34,362	171,810	33,989
All other[a]	7	83,337	389,488	84,910
Total	[b]164	3,192,223	17,735,665	4,168,964

[a] One mill each in Delaware, Maryland, Washington, California, Colorado, Texas, South Carolina.
[b] Operating 237 mills.

WOOD USED.

AMOUNT AND VALUE.

A review of the statistics of the pulp industry as given by the reports of the Bureau of the Census for the years 1899 and 1904 shows an increase of 53.3 per cent. in the amount of woods used, the exact figures being 1,986,310 cords in 1899, and 3,043,459 cords in 1904. In the present report the amount of wood used in 1905 as compared with 1904 shows an increase of 4.6 per cent. The totals given in Table I show that 164 companies operating 237 mills used 3,192,223 cords of wood in 1905, which produced 4,168,964,000 pounds, or 2,084,482 tons of pulp. Statements by manufacturers indicate that the average amount of pulp produced from a cord of wood by the various processes is as follows: Mechanical, 2,372 pounds; soda, 1,033 pounds, and sulfite, 1,009 pounds. The estimate of the quantity of pulp is not wholly satisfactory, since some companies reported dry pulp and others reported pulp containing various amounts of water. Averaging all processes the figures given show a production of 1,300 pounds of pulp per cord of wood.

It has been found impossible to make an accurate comparison of the number of establishments using pulp wood in 1904 and 1905, because the reports of the Bureau of the Census do not differentiate between pulp mills and paper mills. The total number of mills engaged in the manufacture of pulp or paper, or both, in 1904 was 759. In 1905 the number of mills engaged in the manufacture of both pulp and paper was 117, and the number engaged in the manufacture of pulp alone was 120, making the total number of mills manufacturing pulp 237.

SPECIES AND PROCESSES.

Spruce is the wood most used for pulp, furnishing more than 70 per cent. of the total amount. Table II gives statistics of species and processes. The processes, broadly speaking, are two—mechanical and chemical. There are, however, two chemical processes, sulfite and soda, so called because they use sulfurous acid and caustic soda, respectively, in reducing the wood.

The greater portion of the spruce is reduced by the sulfite process. Cottonwood and poplar are reduced almost entirely by

TABLE II.—*Kinds and amounts of wood manufactured into pulp by various processes.*

Kind.	Process.								Per cent.
	Mechanical.		Sulfite.		Soda.		Total.		
	Cords.		*Cords.*		*Cords.*		*Cords.*		
Spruce:									
Domestic	794,260		784,674		71,775		1,650,709		
Imported	230,289		392,256		.....		622,545		
		1,024,549		1,176,930		71,775		2,273,254	71.2
Poplar:									
Domestic	8,592		.....		290,583		299,175		
Imported	2,800		.....		20,083		22,883		
		11,392		.....		310,666		322,058	10.1
Hemlock		30,843		344,579	.....			375,422	11.8
Pine		14,432		18,680		24,367		57,399	1.8
Balsam		10,801		45,943	.....			56,744	1.8
Cottonwood	.....		.....			10,507		10,507	.3
All other		4,777		44,341		47.621		96,739	3.0
		1,096,794		1,630,393		464,936		3,192,222	100.0

the soda process. Next to spruce and poplar, hemlock is most used. It has sprung into favor in a comparatively short time, and is reduced chiefly by the sulfite process. Pine is reduced by all processes. Balsam, a wood scarcely considered for pulp in 1899, is now widely used, mainly in conjunction with spruce. While it furnishes less than 2 per cent. of the total amount of wood used for pulp, it is practically as important as pine and would furnish a much larger quantity were it not for the limited supply.

The totals for all processes show that more wood was reduced by the sulfite process in 1905 than by all other processes combined. The respective proportions are: Sulfite, 51 per cent.; mechanical, 34 per cent.; soda, 15 per cent.

TABLE III.—*Comparison of total amounts of wood used for pulp in 1899 and 1905.*

Process.	1899.	1905.	Increase.	
	Cords.	*Cords.*	*Cords.*	*Per cent.*
Mechanical	786,840	1,096,804	309,964	39.4
Chemical	1,199,470	2,095,419	895,949	74.7
Total	1,986,310	3,192,223	1,205,913	60.7

Table III compares the amount of wood used for pulp in 1899, as given by the twelfth census, with the amount reported to the Forest Service for 1905. This shows that during these six years there was an increase of 60.7 per cent. in the total amount of wood used. The rate of increase was much greater with the chemical process, as there was a gain of 74.7 per cent. in the amount of wood used for chemical reduction, against an increase of 39.4 per cent. in the quantity of wood used for mechanical reduction.

IMPORTED WOOD.

The increasing demand for spruce has made a consequent demand by American manufacturers upon the Canadian spruce forests. This is strikingly shown in Table IV, which indicates that the importations have increased about 75 per cent. in the last six years, while spruce, which constitutes the bulk of the imported woods, increased 83 per cent.

TABLE IV.—*Comparison of wood imported from Canada for pulp in 1899 and 1905.*

Kind.	1899.	1905.	Increase.	
	Cords.	*Cords.*	*Cords.*	*Per cent.*
Spruce	349,084	622,545	293,461	82.9
Poplar	20,133	22,883	2,750	13.6
Total	369,217	645,428	276,211	74.8

DETAILED INFORMATION.

PRODUCTION BY STATES.

As shown by Table I, New York leads all States in number of companies, cords of wood used, and pounds of pulp produced. Of the total number of companies (164) producing pulp, New York has 60, or more than one-third; of wood used, New York takes over one-third of all and more than twice as much as her nearest competitor, Maine; of pulp produced New York furnishes one-third, and three times as much as Maine. New York's annual consumption of wood is more than 1,300,000 cords; Maine's about 500,000 cords. Wisconsin, New Hampshire, Pennsylvania and Michigan follow in the order named. These six States consume the bulk of the wood and have 133 of the 164 companies. In annual capacity the Eastern mills far outrank those elsewhere, New Hampshire leading with an annual average capacity per mill of approximately 290,000 cords. Maine follows with more than 275,000 cords per mill.

Table V carries the State production further than Table I, and shows species and totals by processes.

TABLE V.—*Pulp production in 1905, by species, States, and processes.*

MECHANICAL PROCESS.

State.	Spruce.		Poplar.		Balsam.	Hemlock.	Pine.	Miscellaneous.
	Domestic.	Imported.	Domestic.	Imported.				
	Cords.	*Cords.*	*Cords.*	*Cords.*	*Cords.*	*Cords.*	*Cords.*	*Cords.*
New York	450,639	194,789	2,334	.....	4,610	3,280	1,396	50
Maine	113,518	13,066	1,883	.....	1,442	113	843	.....
Wisconsin	150,763	16,500	2,952	.....	850	.....	4,552	227
New Hampshire	8,769	.....	.....	.....	.....	.....	.....	.....
Pennsylvania	4,200	.....	.....	.....	.....	26,000	.....	.....
Michigan	6,077	100	450	2,800	65	500	741	.....
West Virginia	8,351	.....	.....	.....	.....	.....	.....	.....
Virginia	.....	.....	.....	.....	.....	.....	.....	4,500
Ohio	6,000	1,900	.....	.....	.....	1,000	500	.....
Minnesota	30,302	.....	.....	.....	.....	.....	.....	.....
Vermont	13,422	4,834	373	.....	8,642	.....	.....	.....
Massachusetts	2,000	.....	600	.....	200	.....	.....	.....
All other	.....	.....	.....	.....	.....	.....	6,400	.....
Total	794,260	280,289	8,592	2,800	10,801	30,843	14,432	4,777

SULFITE PROCESS.

State.	Spruce.		Pine.	Hemlock.	Balsam.	Miscellaneous.
	Domestic.	Imported.				
	Cords.	*Cords.*	*Cords.*	*Cords.*	*Cords.*	*Cords.*
New York	321,508	200,335	.....	26,161	17,557	.....
Maine	197,200	14,644	.....	.....	.....	.....
Wisconsin	49,394	.....	.....	154,847	2,386	.....
New Hampshire	74,431	142,000	.....	500	8,000	.....
Pennsylvania	7,815	11,048	.....	64,692	18,000	20,000
Michigan	10,500	17,975	.....	70,215	.....	341
West Virginia	40,532	.....	.....	11,664	.....	.....
Virginia	59,040	.....	.....	.....	.....	.....
Ohio	.....	.....	.....	16,500	.....	24,000
Minnesota	1,500	.....	.....	.....	.....	.....
Massachusetts	22,004	6,254	.....	.....	.....	.....
All other	750	.....	18,600	.....	.....	.....
Total	784,674	392,256	18,600	344,579	45,943	44,341

SODA PROCESS.

State.	Spruce.		Poplar.		Pine.	Cottonwood.	Miscellaneous.
	Domestic.	Imported.	Domestic.	Imported.			
	Cords.	*Cords.*	*Cords.*	*Cords.*	*Cords.*	*Cords.*	*Cords.*
New York	41,455	.....	25,631	12,291	.....	.....	.....
Maine	28,517	.....	123,081	7,500	.....	.....	.....
Wisconsin	.....	.....	.....	.....	.....	.....	.....
New Hampshire	.....	.....	.....	.....	.....	.....	.....
Pennsylvania	.....	.....	36,714	.....	24,367	.....	37,990
Michigan	.....	.....	.....	.....	.....	.....	.....
West Virginia	.....	.....	30,645	.....	.....	.....	5,165
Virginia	.....	.....	26,000	.....	.....	.....	.....
Ohio	.....	.....	3,000	.....	.....	2,000	.....
Minnesota	.....	.....	.....	.....	.....	.....	.....
Vermont	.....	.....	.....	.....	.....	.....	.....
Massachusetts	.....	.....	3,012	292	.....	.....	.....
All other	1,803	.....	42,500	.....	.....	8,597	4,466
Total	71,775	.....	290,583	20,083	24,367	10,597	47,621

GENERAL INFORMATION.

Miscellaneous information of general interest is given in Table VI. The table shows the average daily output of pulp for the mills of each State as reported by the manufacturers. A comparison of these figures with the total amount of pulp manufactured and the number of mills operating for the time given discloses the fact that they are uniformly too large. It is likely, therefore, that the figures submitted by the manufacturers represent more nearly the maximum daily capacity than the average daily output.

TABLE VI.—*General and detailed information of the pulpwood industry.*

State.	Number of companies reporting.	Average months operated.	Claimed average daily output.	Number of companies using the different processes.					Number of companies—							Average value per cord of wood at timber camps.	Estimated length of supply.
				Sulfite.	Soda.	Mechanical.	Sulfite and soda.	Sulfite and mechanical.	Receiving peeled wood.	Receiving rossed wood.	Using slabs.	Carrying on logging operations.	Importing wood from other States or from Canada.		Making both paper and pulp.		
													All.	Prt.			
		No.	*Pounds.*													*P.ct.*	*Yrs.*
New York	60	12	86,900	5	1	43	1	10	55	55	48	49	....	21	40	67	$6.25	19
Maine	18	12	120,900	8	2	5	....	3	14	13	15	14	....	2	12	67	5.88	15
Wisconsin	30	11	54,200	5	....	17	....	7	22	22	22	22	1	19	16	53	4.41	13
New Hampshire	6	12	119,900	3	....	3	....	....	7	7	6	6	....	2	4	67	5.38	28
Pennsylvania	11	12	79,800	2	6	....	....	1	10	10	10	10	1	6	11	100	4.62	15
Michigan	8	12	41,225	5	....	3	....	....	8	6	8	7	....	3	7	88	4.33	20
West Virginia	4	12	68,600	1	....	2	1	....	4	4	4	5	....	....	3	75	5.16	23
Virginia	3	12	101,900	1	1	....	....	1	3	3	3	3	1	1	3	100	5.50	15
Ohio	3	12	49,300	1	1	1	....	1	3	3	4	4	1	2	3	100	5.08	.....
Minnesota	3	12	54,300	....	....	3	....	....	3	3	3	3	....	....	3	100	3.83	.....
Vermont	7	11	24,600	....	....	7	....	....	7	7	6	7	....	2	4	57	5.50	30
Massachusetts	4	12	31,000	2	....	2	....	....	4	3	3	3	1	2	3	75	5.00	25
All others	7	10	46,000	1	3	....	....	3	4	5	6	6	....	....	7	100	4.25	30
Total	164	....	....	34	14	86	2	26	144	141	138	139	5	60	116	....	....	....
Average	....	11.7	69,125	....	....	....	....	....	....	....	....	....	....	....	....	70.7	5.01	21

The utilization of slabs for pulp appears to have become quite common, 138 establishments reporting their use. The precentage which slabs form of the total amount of wood, however, is small, since they rarely constitute over 10 per cent. of the total amount of wood used by a single mill.

Of the 164 companies reporting, 139, or approximately 85 per cent., carry on logging operations, which may also be taken to indicate that they own or control timber land. Only five companies depend wholly upon other States or Canada for their supply.

The price of wood at the point of shipment—in other words, f. o. b. cars or on the banks of a stream—was an item upon which

there was surprising diversity among the firms reporting; the figures in a State often varying from $2 to $10 per cord. In the compilation extreme cases were disregarded, as it was evident that the price given would in some cases no more than cover the actual cost of cutting and driving or hauling, while on the other hand the maximum prices submitted evidently included transportation to the mill. Of the States named, the two Lake States, Minnesota and Wisconsin, are credited with the cheapest raw material, $3.83 and $4.41 per cord, respectively, while in New York the average price is $6.25 per cord. The average price per cord of all is $5.55.

Estimates of the length of time which the supply of timber will last were very consistent within States, and the consensus of opinion is to be found in the averages given in Table VI.

The extent to which the manufacture of paper is combined with the manufacture of pulp is demonstrated in the last section of the table, where it will be noted that the percentage of the mills making both paper and pulp is very high, and, in several instances, all the mills in a State make both.

One of the interesting features brought out by the returns is the sawmill waste and the different kinds of wood now being made into pulp. Among these were noted pitch, jack, and southern pines, maple, birch, beech, white fir, and some of the pines of the Pacific coast. Of sawmill waste, sawdust and veneer cores were mentioned. It is probable that other woods and waste materials may be used for pulp, and the Forest Service has established a laboratory to investigate these possibilities.

Cross-Ties Purchased by the Steam Railroads of the United States in 1905.

BY H. M. HALE,
Forest Assistant.

The following report upon the cross-ties purchased by the railroads in 1905 is based upon statements from 770 steam railroad companies. Of those which failed to report, only one operates more than 1,000 miles of track, and that one less than 1,300. The average mileage of the remainder is approximately 45. The total mileage unreported is 8,671. Since the total trackage in the United States on January 1, 1905, was, according to Poor's Manual, 293,937 miles, the unreported trackage amounts to but 2.9 per cent. of the total.

In presenting this report the Forest Service desires to acknowledge the hearty co-operation of the officials of the various companies throughout the United States in furnishing the necessary data.

These statistics do not necessarily represent the number of cross-ties used in 1905, since they are compiled from the statements of ties purchased. However, there is but little doubt that the law of averages applies sufficiently well in this instance to warrant the assumption that the total represents, with a very fair degree of accuracy, the actual number of ties laid.

PRODUCTION.

The total number of ties reported is 77,981,227, switch ties being reduced to an equivalent number of cross-ties. Of the total number of ties purchased, 14,459,521, or approximately 18.5 per cent., were for use in the construction of new track, leaving 63,521,706 for renewals. It will be noted that this is less than the total announced in the preliminary statement made by the Forest Service under date of May 17, 1906. This is the result of a correction for duplication made in compiling the preliminary report.

Assuming that the unreported 2.9 per cent. of trackage required ties in the same proportion as the reported trackage, the total number of ties purchased by the steam railroads of the United States in 1905 was 81,562,150. Estimating 10,000,000 additional ties for the electric lines, the total number of ties purchased last year in the United States was, in round numbers, 91,500,000.

Table I shows the average cost and the total value of the various kinds of ties. The values given are based upon reports of representative roads in each region and are for ties delivered on the right of way.

TABLE 1.—*Value of ties purchased by steam railroads of the United States in 1905.*

Kind of wood.	Number.	Average cost per tie.	Total.
Oak	34,677,304	$0.55	$19,072,517.20
Pine	18,351,037	.42	7,707,435.54
Cedar	6,962,827	.44	3,063,643.88
Chestnut	4,717,604	.48	2,264,449.92
Red fir	3,633,276	.33	1,198,981.08
Cypress	3,483,746	.33	1,149,636.18
Tamarack	3,060,082	.36	1,101,629.52
Hemlock	1,713,090	.33	565,319.70
Redwood	590,852	.20	118,170.40
Western larch	311,120	.45	140,004.00
Spruce	148,168	.35	51,858.80
Birch	35,500	.40	14,200.00
Beech	34,227	.40	13,690.80
Maple	25,500	.40	10,200.00
Miscellaneous	286,894	.48	113,709.12
Total	77,981,227		36,585,446.14

Table 2 gives, by species, the number and per cent. of hewed and sawed ties purchased during 1905.

TABLE 2.—*Ties purchased by steam railroads of the United States in 1905.*

Kind of wood.	Hewed.			Sawed.			Total.	
	Number.	Per cent of all ties of kind.	Per cent of all hewed ties.	Number.	Per cent of all ties of kind.	Per cent of all sawed ties.	Number.	Per cent.
Oak	30,296,498	87.4	50.2	4,380,806	12.6	24.9	34,677,304	44.5
Pine	11,799,435	64.3	19.5	6,551,602	35.7	37.2	18,351,037	23.5
Cedar	4,842,651	69.6	8.0	2,120,176	30.4	12.6	6,962,827	8.9
Chestnut	3,252,046	68.9	5.4	1,465,558	31.1	8.3	4,717,604	6.1
Red fir	1,410,215	39.0	2.3	2,223,061	61.0	12.6	3,633,276	4.6
Cypress	3,095,760	88.9	5.1	387,986	11.1	2.2	3,483,746	4.5
Tamarack	3,049,972	99.7	5.1	10,110	.3	(a)	3,060,082	4.0
Hemlock	1,599,283	93.4	2.6	113,807	6.6	.6	1,713,090	2.2
Redwood	500,904	84.8	.8	89,948	15.2	.5	590,852	.8
Western larch	247,425	77.9	.4	63,695	22.1	.3	311,120	.4
Spruce	60,190	40.6	.1	87,978	59.4	.5	148,168	.2
Birch	25,500	71.8	.1	10,000	28.2	(a)	35,500	(a)
Beech	6,020	17.9	(a)	28,207	82.1	.1	34,227	(a)
Maple	25,000	98.0	.1	500	2.0	(a)	25,500	(a)
Miscellaneous	187,942	79.3	.3	48,952	21.7	.2	236,894	.3
Total	60,398,841	[b]77.4	100.0	17,582,386	[b]22.6	100.0	77,981,227	100.0

[a] Less than one-tenth of 1 per cent. [b] Per cent of all ties.

The table shows that oak, the greater part of which is doubtless some variety of white oak, furnishes 44.5 per cent., or almost one-half of the total number of ties. Assuming that the average tie contains thirty feet, board measure, the amount of timber represented by the white oak ties is over one billion board feet, or approximately one-fourth of the total amount of oak lumber produced in one year, according to the twelfth census. Nearly all of the oak is converted into hewed ties, only 12.6 per cent. being sawed.

Pine ranks next in importance, with 23.5 per cent., and while it can not be definitely stated just what proportion should be assigned to the various species, it is certain that more than three-fourths of the pine ties are southern yollow pine. The white and Norway pines should be credited with from 3 to 4 per cent. and the western yellow pine of the Rocky Mountain and Pacific Coast regions with from 17 to 18 per cent. These estimates are deductions from Table 3, which shows the number of pine ties which come from each region. Cedar ranks third with 8.9 per cent., followed closely by chestnut with 6.1 per cent. Both of these species are excellent tie woods and would figure more largely in the total production were it not for the limited distribution and supply of each. The percentage of the total number of hewed and sawed ties is, hewed, 77.4; sawed, 22.6.

Statistics are lacking for a comparison of the present output of ties with the number from each kind of timber in other years, but it is very probable that were they available it would be shown that the number and proportion of the pine ties have increased very materially within the last decade. Correspondingly, the proportion of oak ties would doubtless show a decrease for the same period.

The four leading kinds of timber for ties are oak, pine, cedar and chestnut, which combined furnish 83 per cent. of the total number, oak and pine alone furnishing 68 per cent. Next in rank is the red fir of the Pacific Coast and Rocky Mountain region with 4.6 per cent., followed by the cypress of the South with 4.5 per cent. The tamarack, or eastern larch of the New England and Lake States, and the eastern hemlock are the only other species credited with more than 1 per cent. of the total number. Beech,

birch and maple were reported in amounts of less than one-tenth of 1 per cent. each. The miscellaneous classification includes a number of woods, among which the most important are red gum, black locust, elm, hickory and red cedar. Thus some twenty kinds of timber enter into the production of railroad ties, but of these only seven at most are important.

SUPPLY.

Until a comparatively short time ago the railroads were usually able to secure an ample supply of ties from lands adjacent to their rights of way. This has been especially true of the vast network of lines which traverse the territory east of the Mississippi River. While this source is by no means exhausted, it has become seriously depleted, and where in former years the purchasing agent could contract for an almost unlimited number of white oak ties with the assurance that they would be promptly furnished, at the present time it is necessary to contract for small quantities and to anticipate the demand far in advance.

Wherever the whole tree is worked up into ties, sawing permits of by far the closer utilization of material. From this it might be inferred that the present practice of hewing the majority of the ties is poor policy, judged from the standpoint of economy. As a matter of fact, however, little of the material which is converted into hewed ties is saw timber, consisting, as it does, of tops left from lumbering both conifers and hardwoods, or small trees from which, even though sawed, little, if any, additional tie stock could be secured, and heart timber full of knots, shake and similar defects.

Where the tie was once the major product, it is now generally a minor product. The Pacific Coast is practically the only region in the United States where ties are produced as a major product of the forest. One of the most important sources of the ties in the East is the farmer's woodlot. During the winter in this region large numbers of ties are hewed and hauled to the railroads.

In determining the geographical distribution of the regions of supply, it was found impractical to attempt a classification by States on account of the manner in which the railroad companies furnished the information on this item. It was found possible,

however, to determine the source, with a degree of certainty, by grouping the States as follows:

Region.	*States included.*
Southern	Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Arkansas, Texas, Indian Territory.
Central	Ohio, West Virginia, Kentucky, Tennessee, Indiana, Illinois, Missouri.
Lake	Michigan, Wisconsin, Minnesota.
North Atlantic	New England States, New York, Pennsylvania, New Jersey, Delaware, Maryland.
Pacific Coast	Washington, Oregon, California.
Rocky Mountain	Montana, Idaho, Wyoming, Nevada, Utah, Colorado, Arizona, New Mexico.

Table 3 shows, for the various regions, the number of hewed and sawed ties obtained from each kind of timber, arranged in order of importance. The regions are arranged from left to right, according to the number of ties purchased.

TABLE 3.—*Source of supply of ties purchased by steam railroads of the United States in 1905.*

Kind of wood.	Regions.					
	Southern.		Central.		Lake.	
	Hewed.	Sawed.	Hewed.	Sawed.	Hewed.	Sawed.
Oak	11,406,130	570,806	14,554,592	2,966,758	240,824	101,823
Pine	10,197,766	4,182,193	10,400	18,600	641,941	2,420
Cedar		700			4,400,305	1,744,937
Chestnut	114,192	9,145	155,632	22,608		
Red fir						
Cypress	3,087,960	386,986	7,800	1,000		
Tamarack					3,026,193	6,491
Hemlock					1,556,421	44,278
Redwood						
Western larch						
Spruce						
Birch	25,000		500			
Beech	2,500		2,000	1,500		2,000
Maple	25,000			500		
Miscellaneous	15,237	3,460	15,781	11,199	40,985	5,519
Total	24,873,785	5,153,290	14,746,705	3,022,165	9,906,619	1,907,468
Per cent of all ties purchased in region	82.8	17.2	83.1	16.9	83.9	16.1
Total of hewed and sawed	30,027,075		17,768,870		11,814,087	
Per cent	38.5		22.8		15.1	

The Southern States rank first, furnishing over 38 per cent., while the Central States rank next with nearly 23 per cent. of the total number of ties. These groups of States, which comprise practically all of the great hardwood forests of the country and

all of the cypress and southern pine forests, furnish nearly two-thirds of the number of ties. The Lake States rank next with 15 per cent., followed closely by the North Atlantic with about 13 per cent. Thus it will be seen that practically 90 per cent. of the ties are now obtained east of the Rocky Mountains. The Pacific Coast and Rocky Mountain regions, as yet, are not very important factors in the production of ties. This is explained by the fact that these regions at the present time probably do not supply tie material for much trackage beyond their limits, since the long haul to the eastern markets makes it impossible for their ties to compete successfully with ties produced in the East.

TABLE 3.—*Source of supply of ties purchased by steam railroads of the United States in 1905*—Continued.

Kind of wood.	Regions.						Total.
	North Atlantic.		Pacific.		Rocky Mountain.		Hewed and sawed.
	Hewed.	Sawed.	Hewed	Sawed.	Hewed.	Sawed.	
Oak	4,094,952	741,419					34,677,304
Pine	3,137	2,000		1,254,125	946,191	1,092,264	18,351,037
Cedar	412,505	323,176	29,841	25,163		26,200	6,962,827
Chestnut	2,982,222	1,433,805					4,717,604
Red fir			216,696	2,190,581	1,193,519	32,840	3,633,276
Cypress							3,483,746
Tamarack	23,779	3,619					3,060,082
Hemlock	42,862	69,529					1,713,090
Redwood			500,904	89,948			590,852
Western larch			22,730		224,695	63,695	311,120
Spruce					60,190	87,978	148,168
Birch		10,000					35,500
Beech	1,520	24,707					34,227
Maple							25,500
Miscellaneous	115,989	18,774		10,000			236,894
Total	7,676,966	2,627,029	770,171	3,569,817	2,424,595	1,302,617	
Per cent of all ties purchased in region	74.5	25.5	17.7	82.3	65.0	35.0	
Total of hewed and sawed	10,303,995		4,339,988		3,727,212		77,981,227
Per cent	13.2		5.6		4.8		100.0

The method of production in the Pacific Coast region, as compared with other regions, is brought out in a striking manner. It will be seen that the Pacific Coast is the only region in which more sawed than hewed ties are produced, 82.3 per cent. being sawed. Practically the opposite condition is found in the Southern, Lake and Central regions. The Rocky Mountain region follows next in proportion of sawed to hewed ties. Here, however, but 35 per cent. are sawed. This condition is explained in part by the fact that timber is more plentiful and the stumpage value lower in the

West than elsewhere; consequently the market for the lower grades of lumber is poor, and as there is always a ready market for ties, much of the lower grades is sawed into ties. Other factors also have an influence, the most important of which is the sparse population, which deprives the region of the supply obtained from farmers' woodlots, an important feature in the eastern tie market. While it is not to be expected, as with the production of lumber, that the Pacific Coast will ever become the chief source of supply for railroad ties, nevertheless the proportion will doubtless steadily increase.

PRESERVATION.

As a result of the realization that the supply of tie material was not limitless, and more especially when it was found that the durable white oak could no longer be secured in sufficient quantities to meet the demands for renewals and new track, an attempt was made to devise methods for increasing the length of service of the inferior woods. Tie plates were introduced with marked success in reducing the wear when used on soft woods. It was soon found, however, that the tie plate was not sufficient, since the wood decayed so rapidly that renewals in a short time were often necessary. To meet this problem, experiments in preservative treatments of ties were taken up by several railroad companies, some of them working in co-operation with the Forest Service, and it seems safe to predict that within a comparatively short period of time more treated than untreated ties will be used. The statistics of 1905 show that 7,510,000 ties, or nearly 10 per cent. of the total number purchased, were given a preservative treatment of some character.

During 1905 at least ten railroad companies were operating their own plants for the preservation of their construction material, and several others are contemplating the installation of such plants. In addition to the roads which treat their own timber, many others have their timber treated at commercial treating plants.

Approved:

W. M. HAYS,
Acting Secretary.

Washington, D. C., August 22, 1906.

Consumption of Tanbark in 1905.

BY H. M. HALE,
Forest Assistant.

The statement of the consumption of tanbark in 1905 here given is based upon the reports of 222 firms operating 477 tanneries. The total amount of bark reported is 1,104,045 cords, of which hemlock constitutes 799,755 cords, or 73 per cent., and oak 304,290 cords, or 27 per cent. The average price per cord reported for hemlock bark is $6.32 and for the oak bark $10.44, making a total value of $8,232,457.

In presenting these statistics the Forest Service desires to acknowledge the efficient co-operation of the tanners throughout the United States in furnishing the desired information.

Table 1 shows by States, the number of tanneries reporting, and the quantities, per cent. and value of the hemlock and oak bark purchased in 1905.

It will be seen that the tanneries of Pennsylvania lead in the quantity of bark purchased, the total being 428,709 cords, of which 379,806 cords were hemlock and 48,903 cords oak. This is nearly double the quantity of bark purchased in Michigan, the State which ranks next in importance. Pennsylvania and Michigan are by far the largest users of bark, particularly hemlock, and together these two States purchased over 60 per cent. of the total quantity reported. In the purchase of oak bark Virginia holds first place with 73,871 cords.

Since tanneries are usually located in or near the regions from which they draw their supply of bark, the assumption may fairly be made that, on the whole, the figures for purchases also represent approximately the production in the States mentioned. On this assumption, the leading States in the production of hemlock bark are Pennsylvania, Michigan, Wisconsin, West Virginia, Maine and New York in the order named, aggregating 97 per cent. of the total production. Similarly, over 90 per cent. of the oak bark is produced by the following States: Virginia, California, Pennsylvania, West Virginia, Tennessee, North Carolina and Kentucky.

TABLE 1.—*Tanbark purchased by tanneries in 1905.*

QUANTITY.

State.	Number of tanneries.	Hemlock.		Oak.		Total cords.	Per cent of purchases in State to that of total in United States.
		Cords.	Per cent.	Cords.	Per cent.		
Pennsylvania	52	379,806	88.5	48,903	11.5	428,709	38.9
Michigan	60	240,652	100.0			240,653	21.8
West Virginia	33	37,845	49.9	37,985	50.1	75,830	6.8
Virginia	55	1,238	2.0	73,871	98.0	75,109	6.8
Wisconsin	18	68,247	100.0			68,247	6.2
California	36			50,007	100.0	50,007	4.5
Tennessee	28	3,651	11.0	28,683	89.0	32,334	2.9
Maine	23	29,750	100.0			29,750	2.7
North Carolina	17	1,215	4.0	27,866	96.0	29,081	2.6
New York	51	19,916	99.4	137	.6	20,053	1.8
Kentucky	28	57	.4	17,681	99.6	17,788	1.6
Vermont	12	7,497	100.0			7,497	.7
Maryland	6	60	.8	7,423	99.2	7,483	.7
New Hampshire	11	5,032	100.0			5,032	.5
Ohio	11	341	7.7	4,123	92.3	4,464	.4
Massachusetts	4	2,339	100.0			2,339	.2
Georgia	13			4,457	100.0	4,457	.4
Alabama	3			1,500	100.0	1,500	.1
New Jersey	5	459	32.5	957	67.5	1,416	.1
Oregon	3	975	100.0			975	.1
Indiana	3			485	100.0	485	.1
All others	5	675		212		887	.1
Total	477	799,755		304,290		1,104,045	100.0

VALUE.

State.	Hemlock.		Oak.		Total.
	Average price per cord.	Amount.	Average price per cord.	Amount.	
Pennsylvania	$7.54	$3,863,737	$8.40	$410,785	$3,274,522
Michigan	7.02	1,689,377			1,689,377
West Virginia			7.75	294,384	294,384
Virginia			7.87	581,365	581,365
Wisconsin			7.07	482,506	482,506
California			19.04	952,133	952,133
Tennessee	6.30	23,001			23,001
Maine	6.80	202,300			202,300
North Carolina			6.17	171,933	171,933
New York	7.07	140,806	11.00	1,507	142,313
Kentucky	11.25	641	8.86	156,654	157,295
Vermont	6.87	51,504			51,504
Maryland	5.00	300	6.00	44,838	45,138
New Hampshire	7.75	38,998			38,998
Ohio	9.74	3,321	9.55	39,375	42,696
Massachusetts	9.75	23,005			23,005
Georgia			5.64	15,137	15,137
Alabama			5.64	8,460	8,460
New Jersey	12.68	5,820	11.75	11,245	17,065
Oregon	8.00	7,800			7,800
Indiana			9.24	4,161	4,161
All others	8.13	5,488	8.85	1,876	7,364
Total		5,056,098		3,176,359	8,232,457

In addition to bark and chemicals, the tanneries use large quantities of extracts made from hemlock and oak bark and chestnut wood, together with a considerable amount of imported quebracho

and gambier. Sumach leaves and palmetto extracts are also used to some extent.

Table 2 gives the amount of domestic bark and extracts used by the tanneries in 1900, as reported by the twelfth census, compared with the figures gathered by the Forest Service for 1905.

TABLE 2.—*Consumption of domestic bark and extracts in 1900 and 1905.*

Kind.	Bark.		Extract.	
	Census, 1900.	Forest Service, 1905.	Census, 1900.	Forest Service, 1905.
	Cords.	*Cords.*	*Barrels.*[a]	*Barrels.*[a]
Hemlock	1,170,131	799,755	12,812	52,480
Oak	445,934	304,290	54,231	187,635
Chestnut	----------	----------	----------	51,224
Palmetto	----------	----------	----------	1,110
Total	1,616,065	1,104,045	67,043	292,399

[a] Barrel equivalent to 500 pounds.

While the census figures upon bark for 1900 are 512,020 cords greater than those of the Forest Service for 1905, the amount of extract reported to the Forest Service is 225,356 barrels in excess of the amount shown by the census. This indicates that while the figures of the Forest Service are incomplete, owing to the failure of some firms to report, there is undoubtedly a rapidly growing tendency on the part of the tanners to partially replace bark with extracts.

During the period which has elapsed since the twelfth census was taken the use of the extract of quebracho, a South American tree, has largely increased. Quebracho contains a very high percentage of tannin and gives excellent results when mixed with various quantities of domestic barks or extracts. This extract can be imported at a price which compares very favorably with the present price of domestic barks, and the drain on the supply of tanbark in the United States is thus considerably relieved. Unfortunately, statistics showing the importation of quebracho for the calendar year of 1905 are not available because the figures for this extract have not until recently been kept separate from those for other extracts. An indication of the extent to which it is imported, however, can be gained from the statistics for the month of July, 1906, which give 7,244,205 pounds, or 14,480 barrels, with a value of $207,095. Estimating on this basis for twelve months gives an

importation of approximately 87,000,000 pounds, with a value of $2,480,000. A comparison of these figures with those of the twelfth census for the amount of quebracho used in the manufacture of leather in 1900, which was only 20,360 barrels or bales, with a value of $292,133, gives some idea of the great increase in the use of this extract. Other tropical products are also receiving considerable attention by progressive tanners with a view of supplementing our native supply to a still greater extent.

The imports of hemlock bark from Canada show a marked decrease, as will be seen by the following statement for the last three fiscal years taken from the report of the Bureau of Statistics of the Department of Commerce and Labor for June, 1906:

TABLE 3.—*Imports of hemlock bark by fiscal years.*

Year.	Cords.	Value.
1904	14,111	$68,460
1905	13,511	64,181
1906	7,467	35,860

Not only have substitutes for bark been found, but the processes in use have been greatly improved, so that in the best equipped tanneries at the present time from 20 to 30 per cent. more leather can be tanned with the same amount of bark than was possible a few years ago.

Since the statistics of the twelfth census on the materials used by the manufacturers of leather do not indicate the number of establishments using bark or wood extracts, it is impossible to determine whether the number of establishments has increased or decreased during the period from 1900 to 1905. The total number of establishments, according to the census, engaged in the manufacture of leather in 1900 was 1,306, but this includes the manufacturers of both sole and upper leather. No bark or wood extracts are used in tanning uppers, and so no reports from such tanners were received by the Forest Service.

Approved:

JAMES WILSON,
Secretary of Agriculture.

Washington, D. C., August 17, 1906.

Wood Used for Veneer in 1905.

BY H. M. HALE,
Forest Assistant.

The figures given in this circular were compiled from statements of 128 manufacturers of veneer throughout the country. As was to be expected in a new statistical investigation, returns were not entirely complete, though they clearly indicate the relative importance of the various woods used.

The absence of figures in the census reports shows that, down to 1900, veneering had not assumed the importance of an industry worthy of special attention. At the present time, however, there are in the United States over 128 establishments which cut veneer, using annually more than 189,000,000 feet log measure, the equivalent of approximately 217,000,000 board feet, which yields 1,108,000,000 square feet of veneer. It is evident that the growth of the veneer industry has been strikingly rapid.

Veneers are of three general classes—sawed, sliced and rotary-cut. Sawed veneers, which have been longest used, are of highest grade. Sliced veneers rank next in order of quality. Although the returns from the manufacturers do not indicate the exact process, there is little doubt that 75 per cent. of the oak veneers are either sawed or sliced. The rotary process is very extensively employed for all woods except oak.

Table 1 shows the quantity and percentage of each kind of timber used and the number of square feet of veneer manufactured in 1905. The returns from the manufacturers gave the quantity of wood used in log scale; these figures are tabulated under the caption of "log scale." Since the mill scale will, on an average, overrun the log scale about 20 per cent., in computing the average number of square feet of veneer produced per foot board measure the log scale was converted into mill scale by increasing each item 20 per cent., in the belief that results so obtained would be more accurate than those based on log scale.

It should be noted that the results do not represent the average thickness of the veneers, as might at first be supposed, because the item of board feet carries the gross amount of wood in the log,

while the item of square feet of veneer includes the finished, salable product only, no account being taken of the waste from reducing the log to a true cylinder or from saw kerf, slabs, or defective parts of logs and cores. For example, when veneers are sawed one-twentieth of an inch thick, another one-twentieth of an inch is lost in saw kerf, so that, even provided all the other forms of waste are saved, not more than ten thicknesses can be obtained from a board an inch thick.

TABLE 1.—*Wood used and veneer stock produced in 1905.*

Kind.	Per cent.	Log scale (1,000 feet).	Veneer (1,000 square feet).	Average number square feet veneer per foot B. M.
Red gum	21.8	39,573	187,940	3.9
Maple	14.5	26,246	179,809	5.7
Yellow poplar	14.4	26,164	151,566	4.8
Cottonwood	9.0	16,357	45,223	2.3
White oak	8.9	16,129	115,265	6.0
Yellow pine	7.0	12,688	41,069	2.7
Birch	7.0	12,643	128,521	8.5
Basswood	6.3	11,376	82,925	6.0
Elm	3.1	5,544	60,708	9.0
Red oak	2.7	4,955	31,054	5.2
Ash	1.3	2,461	21,648	7.3
Walnut	1.0	1,725	21,181	10.2
Beech	.8	1,400	18,765	11.1
Sycamore	.3	576	1,435	2.1
Tupelo	.2	314	1,806	4.8
Miscellaneous	1.7	2,995	19,603	5.5
Total	100.0	181,146	1,108,518	5.1

The importance of red gum, which furnishes in this industry 21.8 per cent. of the raw material and nearly 17 per cent. of the veneer, is clearly indicated. This is the more striking when it is remembered that this species has been utilized only a few years.

Maple ranks second in quantity of raw material, and furnishes 14.5 per cent. Yellow poplar is the only other kind of timber furnishing more than 10 per cent. of the raw material. It ranks third both in quantity of wood and square feet of veneer. These three species, red gum, maple and yellow poplar, furnish more than one-half of the total quantity of wood used.

White oak, although ranking fifth in the scale of quantity, holds a high place among the veneer woods. Probably no other veneer is so much in demand as this, and if data were available to show its exact value the result would be a revelation to those not thoroughly familiar with the situation.

The results show that for all species the average number of veneers produced per foot board measure is 5.1. Of the individual species, beech is cut the thinnest, the average being 11.1 square

feet per board foot. This is doubtless due in part to the fact that this is a favorite wood for the manufacture of wooden plates, and such stock is cut about thirty to the inch. Walnut ranks next, with 10.2 to the inch. The fact that it is a scarce and valuable wood readily accounts for this. Sycamore, cottonwood and pine are cut thickest.

The use of a large number of species for veneering is shown by the reports. While the fifteen kinds tabulated constitute by far the greater part of the wood used, there are nearly as many more used in small quantities, among which are cherry, chestnut, butternut, hickory, cucumber and holly. It will be noted that in Wisconsin the leading wood is basswood; in Tennessee, red gum; in Indiana, white oak; in New York, maple, and in Missouri, cottonwood.

Not all of the wood classed as veneer is actually used for veneering in the true sense, for with the development of veneering machinery a number of new uses have been found for wood in the form of veneer. Such of the softer woods as gum, cottonwood and poplar, are largely veneered for boxes, baskets, egg crates, and similar products. Such woods do not yield high-grade veneers, but are used extensively for building up panels to be finished with a choice wood.

Woods which take a good finish and possess a pleasing grain or color, such as oak, maple, birch or walnut, furnish the bulk of the true veneers; in fact it may safely be assumed that practically all of the walnut and oak and a large percentage of the maple shown in this report are used in this way. Furniture, and to a limited extent, interior finishing, consume the most of these species.

One of the most difficult problems to solve in the handling of veneer stock is the drying. A query in regard to drying methods was sent to manufacturers, but the replies failed to indicate a marked preference for any one method. One-third of the establishments use no artificial process. It does not follow, however, that as much as one-third of the veneer is dried in the open air. On the contrary, probably much less than one-third is so dried.

The economical use of the cores which remain after a log is cut by the rotary process is a problem of such general interest that inquiry was made on the schedules as to the present practice. The results show that 39 establishments use all cores for fuel; 50 use all

or part of them for fuel; 33 convert them into excelsior. One reports use for pulp; another their use for porch posts. The remainder report various uses, chiefly, however, combinations of lumber, excelsior, crates, boxes and baskets.

TABLE 2.—*Wood used for veneer stock, by States.*

State.	Firms reporting.	Aggregate log scale.	Per cent.	Red gum.	Maple.	Yellow poplar.	Cottonwood.	White oak.	Yellow pine.
		1,000 board feet.		*1,000 board feet.*	*1,000 board feet.*	*1,000 board feet.*	*1,000 board feet.*	*1,000 board feet.*	*1,000 board feet.*
Alabama	4	3,711	2.1	2,300	.....	1,061	.....	.....	250
Florida	3	5,598	3.1	.....	.....	.....	.....	.....	5,598
Georgia	3	1,419	.8	6	.....	205	.....	.....	1,208
Illinois	5	12,838	6.9	9,598	170	509	415	.....	.....
Indiana	10	17,556	9.7	1,500	1,500	1,327	.....	8,050	.....
Kentucky	3	4,673	2.6	850	50	2,612	.....	875	.....
Louisiana	3	2,960	1.6	300	.....	160	2,000	.....	250
Maine	3	2,570	1.4	.....	.....	20	.....	.....	.....
Maryland	3	2,630	1.5	330	100	880	.....	900	.....
Michigan	13	11,732	6.5	.....	6,499	100	.....	696	.....
Missouri	5	13,119	7.3	5,628	613	4	3,292	856	.....
New York	12	17,479	9.7	.....	14,438	.....	.....	585	.....
North Carolina	12	7,521	4.2	3,022	.....	4,069	.....	180	230
Ohio	5	5,093	2.8	.....	100	2,000	.....	2,568	.....
Pennsylvania	3	1,550	.9	.....	400	250	.....	.....	.....
South Carolina	4	12,016	6.7	2,613	.....	4,328	.....	.....	5,062
Tennessee	3	19,700	10.9	9,000	.....	3,000	7,500	150	.....
Virginia	6	5,010	2.8	3,500	1	969	.....	401	100
West Virginia	3	3,475	1.9	.....	2	3,361	.....	114	.....
Wisconsin	16	22,785	12.6	.....	1,475	100	.....	774	.....
All others[a]	9	7,531	4.2	926	900	1,109	3,150	11	.....
Total	128	181,146	100.0	39,573	26,246	26,164	16,857	16,129	12,688

State.	Birch.	Bass-wood.	Elm.	Red oak.	Ash.	Beech.	Sycamore.	Tupelo.	Miscellaneous hardwoods.
	1,000 board feet.	*1,000 board feet.*	*1,000 board feet.*	*1,000 board feet.*	*1,000 board feet.*	*1,000 board feet.*	*1,000 board feet.*	*1,000 board feet.*	*1,000 board feet.*
Alabama	.....	.....	.....	.....	.....	.....	.....	.....	100
Florida	.....	.....	.....	.....	.....	.....	.....	.....	.....
Georgia	.....	.....	.....	.....	.....	.....	.....	.....	.....
Illinois	170	.....	262	.....	4	.....	5	.....	1,705
Indiana	1,220	367	366	1,056	200	.....	.....	.....	1,970
Kentucky	.....	.....	.....	225	61	.....	.....	.....	.....
Louisiana	.....	.....	.....	.....	.....	.....	.....	.....	250
Maine	800	1,750	.....	.....	.....	.....	.....	.....	.....
Maryland	30	.....	.....	300	10	.....	80	.....	.....
Michigan	728	1,612	1,067	110	518	400	.....	.....	3
Missouri	22	.....	1,148	269	90	.....	491	274	432
New York	631	543	489	311	332	200	.....	.....	.....
North Carolina	.....	.....	.....	20	.....	.....	.....	.....	.....
Ohio	.....	150	125	5	.....	100	.....	.....	25
Pennsylvania	.....	.....	400	.....	.....	500	.....	.....	.....
South Carolina	.....	.....	.....	.....	3	.....	.....	20	.....
Tennessee	.....	.....	.....	50	.....	.....	.....	.....	.....
Virginia	.....	10	.....	20	9	.....	.....	.....	.....
West Virginia	.....	.....	.....	.....	.....	.....	.....	.....	.....
Wisconsin	8,240	6,914	1,487	2,589	971	.....	.....	.....	285
All others[a]	802	30	200	.....	263	200	.....	20	.....
Total	12,643	11,376	5,544	4,955	2,461	1,400	576	314	4,720

[a] Delaware, Mississippi, New Jersey, Vermont, Washington.

GIFFORD PINCHOT, *Forester.*

Approved:

JAMES WILSON, *Secretary.*

Washington, D. C., October 19, 1906.

Wood Used for Distillation in 1905.

BY H. M. HALE,
Forest Assistant.

The following statistics of the wood used for and the products of distillation in 1905 have been compiled from reports made by the operators of eighty-two distillation plants throughout the United States. The returns give the amounts of softwoods and hardwoods, but not the separate amounts of each kind in each class. Of the hardwoods, it is safe to say that beech, birch and maple furnished over 80 per cent. of the amount, while oak and other kinds of timber furnished the remainder. Of the softwoods, all of which are native to the South, long-leaf pine probably furnished by far the greatest amount.

The tables show that the total consumption of the eighty-two plants was 676,739 cords, valued at $2,010,611; and that the products comprise 26,670,139 bushels of charcoal, 5,062,076 gallons of alcohol, 86,685,129 pounds of acetate of lime, 238,180 gallons of turpentine, and 1,039,980 gallons of tar and oil, besides 434,780 gallons of oil from pine distillation. The total for tar distillation from hardwoods is very small. As a matter of fact, the figures do not even approximate the actual amount, but, instead, represent only the amount saved and refined. Owing to certain characteristics of the tar obtained from hardwoods, which make it of low commercial value, most of it is used for fuel, either in carbonizing the wood or in refining the liquor, and when so used no record is kept of the quantity produced.

HARDWOOD DISTILLATION.

Tables 1 and 2 give the quantity of hardwood distilled and of the products. It will be seen that three States—Michigan, Pennsylvania and New York—are in the lead. Of the States included under the heading "All others," Missouri ranks first. It may therefore be asserted that the hardwood distillation industry is practically confined to these four States. The sixty-seven plants

reported from these States 659,770 cords of hardwood, with a total value of $1,967,806. The products were 26,370,033 bushels of charcoal, 5,062,076 gallons of alcohol, and 86,685,129 pounds of acetate. For the reason already given the amount of tar, oil, etc., is not correctly represented by the figures given.

TABLE 1.—*Hardwood distillation.*

State.	Number of establishments.	Wood used.		
		Cords.	Average value per cord.	Total value of raw material.
Michigan	6	239,992	$2.61	$627,521
New York	22	119,987	3.20	383,691
Pennsylvania	35	242,519	3.51	851,579
All others[a]	4	57,322	1.84	105,015
Total	67	659,770	.....	1,967,806

[a] Kentucky, Maine, and Minnesota.

TABLE 2.—*Hardwood distillation.*

State.	Products.			
	Charcoal.	Crude alcohol.	Acetate.	Tar and oil.
	Bushels.[a]	*Gallons.*	*Pounds.*	*Gallons.*
Michigan	8,143,387	1,246,121	14,778,695	549,780
New York	4,986,865	1,392,995	26,392,564	20,000
Pennsylvania	10,478,794	2,324,329	45,778,093	80,750
All others[b]	2,760,987	98,631	735,777	27,000
Total	26,370,033	5,062,076	86,685,129	677,480

[a] Bushel equivalent to 20 pounds
[b] Kentucky, Maine, and Minnesota.

Pennsylvania leads in the amount of charcoal per cord, the results showing an average of 860 pounds, or 43 bushels. New York ranks second, with 840 pounds, or 42 bushels. Michigan, with but 680 pounds, or 34 bushels, is in striking contrast to the average production. In number of gallons of alcohol produced per cord, New York leads both Pennsylvania and Michigan, with an average of 11.6 gallons, followed closely by Pennsylvania, with an average of 9.6 gallons. The average for Michigan is but little more than half of either of these States, namely, 4.8 gallons. This may be due to the fact that in New York and Pennsylvania the wood is carbonized almost entirely in retorts, while in Michigan the brick kiln with direct fire is generally employed.

PINE DISTILLATION.

Tables 3 and 4 show the quantity of pine distilled and the products. Compared with the figures for hardwood, the quantity is insignificant; the total amount used by the fifteen operators reporting was but 16,969 cords, with a value of $42,805. The products differed, of course, from those of hardwood distillation, in containing a large amount of tar and turpentine, but no alcohol. Much less charcoal is obtained from pine than from hardwood, the average relative proportions being approximately 350 pounds per cord, as against approximately 700 pounds per cord. Tar, a by-product in hardwood distillation, is one of the major products of pine distillation. The average price of pine wood per cord is also lower.

TABLE 3.—*Pine distillation.*

State.	Number of establishments.	Wood used.		
		Cords.	Average value per cord.	Total value of raw material.
Georgia	4	8,925	$2.65	$23,643
North Carolina	5	4,624	2.46	11,387
South Carolina	4	1,970	1.74	3,425
All others	2	1,450	3.00	4,350
Total	15	16,969	.....	42,805

TABLE 4.—*Pine distillation.*

State.	Products.			
	Charcoal.	Tar.	Oil.	Turpentine.
	Bushels.[a]	*Gallons.*	*Gallons.*	*Gallons.*
Georgia	70,000	130,000	259,000	98,750
North Carolina	102,366	105,000	113,780	66,280
South Carolina	76,000	55,000	62,000	51,400
All others	51,750	72,500	.....	21,750
Total	300,106	362,500	434,780	238,180

[a] Bushel equivalent to 20 pounds.

GIFFORD PINCHOT,
Forester.

Approved:
JAMES WILSON,
Secretary.

Washington, D. C., October 19, 1906.

Miscellaneous Papers Upon Topics of Forestry

FOREST LAND TAXATION.

The ideas contained in the following discussions of taxation were attempted in a bill for enactment into a law before the Indiana General Assembly of 1905, but was ascertained to be unconstitutional, and consequently was abandoned. The ideas contained in the bill attempted to be enacted were original with the Board of Forestry at the time, and it is believed if such a law could be made and honestly obeyed it would be of value to forestry and the State.

How Shall Forest Lands be Taxed?* (In Two Parts)

PART II.—A Proposition to Encourage the Growing of Forests for Profit.

BY ALFRED GASKILL.
Forest Inspector, U. S. Forest Service.

HOW FORESTS SHOULD BE TAXED.

On approaching this subject one naturally turns to those European countries in which forestry has become an art, for, manifestly, no oppressive burden of taxes could be borne where the growing of trees is found to be so profitable. The conclusions from such a study are two: (1) That the systems of taxation are so radically different from ours that only general principles can be applied here; and (2) that the assessments are always based on the actual value of the forest, or on the earning power of the land, that is, its yield.

The first principle in all these laws is that the forest shall be considered and rated apart from the land upon which it stands. This principle finds universal acceptance in theory at least, though the practice differs in the various countries, and is based upon the fact that a forest is a crop of many years' growth and represents the owner's savings—the accumulated capital and interest on a time investment. This fact is as obvious here as it is there, and in my opinion makes its necessary for us to admit that in any piece of forest property the soil alone is realty, the growing trees are reinvested income—that is personalty.†

To illustrate: A man has two fields. On one he raises corn, and year by year puts the value of the crop in bank or buys securities, which he holds and on which he pays, or should pay, a personal property tax. On the second field he plants trees; they thrive and make a good growth, but at the end of the season they are not convertible into money as the corn crop was. So it is for

*Paper read before Society of American Foresters and Fourteenth Annual Meeting of the National Wholesale Lumber Dealers' Association.

†The forests of the German States, for instance, are estimated to have 75 per cent. to 85 per cent. of their value in the timber and 25 per cent. to 15 per cent. in the land.—M. Endres, "Forsten," in Conrad's Handworterbuch der Staatswissenchaften, 1900.

many years. The tree crop is made each season, but must be left on the stump until enough wood is accumulated to make it salable. Suppose the farmer, instead of selling his corn, had put it into a crib and added the second and third and each succeeding year's crop to the first; would he not accumulate personalty in the crib of corn? He does the same with the product of his trees, but the result shows this difference: The crib of corn earns no increase; it represents only simple interest on the land; it is not like the money in bank that might have been obtained by selling the corn, which would earn compound interest by being reinvested with the accrued interest every year. In the growing forest, however, the increase in value is reinvested; the owner expects his trees to yield him a profit on the capital which they themselves represent, as well as on the capital which the land represents. But the two values—that of the trees and that of the land—are distinct.

It is thus evident that because the tree grower must reinvest his annual crop in stumpage it is no reason for considering it real estate. In the view that forests can be reproduced, trees are virtually movables, and the practice of rating them a part of the land is the fundamental error in every American State.

Theoretically it is as proper to tax growing grain as growing trees; but since the grain matures in one year, while the trees require many, and all our fiscal arrangements are based on annual returns, the trees should be taxed though the grain be exempt. Here, however, comes in the second principle in the taxation of forests, that it is unjust to require the owner to pay so long as the forest yields him nothing. There is no equity in making a man's other property carry his immature forest. In practice this works out in various ways. Most of the German States have not yet made the principle effective, but Baden exempts newly-established forests from tax for twenty years (law of 1886). In Austria they are exempt for twenty-five years (law of 1869). In France three-fourths of the land tax is remitted for thirty years.‡ In connection with these laws it should be remembered that forests in Europe begin to yield salable material when they are from twenty to thirty years old. In most parts of the United States the pro-

‡M. Endres, Die Besteuerung des Waldes, in Forstwissenschaftliches Centralblatt p. 509, 1899.

ductive period begins later because there is no market for small wood.

This principle of exemption or rebate is familiar enough in this country, where undeveloped property of all kinds is taxed at a nominal rate. Farm land not cleared bears little. A comparison can not be made, however, with other forms of unproductive property—city lots, for instance. The owner of the latter produces nothing from his land; he hopes to gain by what others do. The forest owner, on the other hand, does produce something of value and will eventually pay a proper tax on it.

One reason why forest property is held in such high esteem in most of the countries of Europe is that the taxes are levied fairly. No matter how high the rate in any locality may be, the owner has the assurance of absolute equity in the valuation.

It would be impossible to apply the European system here with anything like the exactness that attaches to it in the old countries, because we have not the means of knowing the true worth of forest soil or of forest crops, but the principle is applicable anywhere. Even in the hands of non-expert assessors it gives a fairer basis of valuation than our present method, and in the long run will insure larger returns.

This is the equity of forest taxation; but the communities have another interest than that of revenue, namely, to maintain the forests in the greatest possible extent and effectiveness for the sake of lumbering and its many dependent industries, and for the influence that they have upon stream flow and the modification of climatic extremes. These subjects are beginning to be well understood, and need not be dwelt upon.

POINTS TO BE CONSIDERED.

The points that, in the writer's opinion, should be considered in any equitable scheme of forest taaxtion are the following:

(1) Forests are necessary to the public welfare, and consequently each commonwealth should bear a part of the cost of maintaining them. This means that the State treasuries should assume a considerable part of the obligation, and, as far as is proper, relieve the counties, because a region that is rich in forest is poor in everything else—population, farms, industries—and it is right

that the cities and towns should contribute to the maintenance of conditions that are as important to them as they are to the people who live close to the forest borders. Exemptions and rebates, as usually allowed, do not meet this requirement, because the county bears the burden; that is, if one piece of property pays less, all the rest must pay a higher rate to make up the deficiency. In no case are exemptions justified, unless everyone who shares the burden of it is correspondingly benefited. If a piece of private forest serves to protect a drainage area, or is valued for its beauty, it is right for all who enjoy or profit by it to pay a proper share of the local taxes. For instance, if a town or village wants the owner of a woodlot to keep it for the people's pleasure they may remit the taxes on it, because no one else is concerned.

But a State can not properly declare that its forest reserve shall be untaxed, because such action robs the counties of the revenue that they need. New York, which holds the largest State reserve, recognizes this principle and pays local taxes on its land. The Austrian state forests pay taxes on land and income. With our national holdings the same principle should apply in all cases where land previously subject to taxation is taken over.*

(2) A forest is a form of property whose value is potential or prospective most of the time; only when the trees are market ripe can an income be derived from it.

(3) In consequence of yielding periodic returns, the greater part of the tax to be paid upon a forest should fall due when the timber is sold, and not to be made a burden upon the other property of the owner through many years. The periods at which forests may yield returns should not be considered as the full time required to grow the average tree; some trees mature more quickly than others, and all natural forests contain trees of various sizes and ages. It is doubtful if any forest containing the usual diversity in size or species, and now market ripe, would not yield again within twenty years if cut carefully. This point is often overlooked, yet it is of great importance in considering the periods during which a given piece of forest would pay only on the ground tax.

(4) The deferred tax should bear a fair relation to the net yield

*Under a new law enacted in 1905, Pennsylvania pays to the counties, in lieu of taxes, 5 cents a year for each acre of State land.

of the property; that is, it should not exceed a sum that will leave the owner the equivalent of a fair annual return on his investment.

(5) Forests occupying land of the kind here considered grow too slowly in most situations to yield by their annual increment a rate of interest comparable with that commonly expected from ordinary business enterprises; they may easily produce wood at a rate that will compare favorably with the interest derived from State or national obligations.

(6) Forests are exposed to unusual risks from fire and depredation, owing to their very general use by the public.

OBJECTIONS.

What are the objections that may be urged to a law embodying those principles? The fundamental proposition—that forests be assessed apart from the land upon which they stand—suggests a radical change in the tax system of most States; but forestry itself is radical and demands new methods. Apart from that the only difficulty is to fix the values of land and forest. If it be admitted that forest owners are entitled to special rates on such property on account of its public value, the constitution of no State is likely to prove a bar to the necessary legislation, since existing bounty and exemption acts evidence the power of the legislatures. But if such difficulty be encountered it probably can be overcome by putting forests into a special class for purposes of taxation. The real questions, then, are how to fix the value of a forest and how to provide for the collection of the tax at intervals. The problem is less difficult than it appears to be. If the land alone is made to pay a yearly tax on its actual value, determined by the assessors in the usual way, the county gets at least as much income as it would if the forest were not there.

Then let the whole question of timber value be determined by what it sells for, and base the forest tax on that. Everything that comes out of the forest must pay the accepted rate of tax. Of course, safeguards must be provided; intermediate yields as well as the main crop must pay their shares, a proper return of quantities and value of material sold or used must be insured, and provision made for an adjustment of loss in the event of seri-

ous damage to the property by fire or storm. If theft is committed, it may be assumed that the county is equally responsible with the owner. The county being thus protected against loss, the owner, on the other hand, must be assured that the rate will not be raised when it is known that his timber is ready for market. The deferred returns from this source would be viewed as sinking-fund accumulations, or they might be used as a basis for bond issues to supply special needs.

A law framed along these lines would, of course, have to be adapted to local conditions and practices. Its proper execution would involve some increase in the executive personnel, yet even without that the change could not fail to be an improvement on the present system.

HOW THE PLAN WOULD WORK.

It is difficult to illustrate this plan as applied to a forest already grown, but which may not be cut for several years, without accurate knowledge of the value of the stand and of local conditions. Perhaps it would be found safe and entirely reasonable, in most cases, to remit the taxes until the trees were cut, and then collect a definite proportion of the net yield for each year that tax has been unpaid. The difficulty naturally is to determine what that proportion should be, and it can only be settled by applying the principle to concrete cases.

But it is possible to find an illustration in an example of a forest grown on ground that is now bare. Let it be assumed that 50,000 acres of pine land in Michigan, valued at $1 per acre, will yield, eighty years hence, 350,000,000 board feet of lumber, worth $7 per thousand on the stump. The figures are conservative, and if a young forest be already started on a portion of the area, so much the better. If the local tax levy is 2 cents, on a two-thirds valuation, the land will pay to the county $1\frac{1}{3}$ cents per acre, or $666.67 per year. Then, if the State pay half a cent per acre on account of the public utility of the forest (see table) the county will receive $250 more, or a total of $916.67 yearly. In practice, the forest would begin to yield something after thirty or forty years, but for the sake of simplifying the calculation let it be assumed that it is all cut at the end of eighty years. How

much of the sale price should the county get? The forest at one year old is actually worth nothing, hence no tax can properly be charged against it. At two years old it is nearer maturity, but still has only an "expectation value," based upon what the mature trees may yield. In short, the value increases year by year from nothing to $2,450,000, when it is 80 years old.

The values upon which a tax might be levied each year are thus difficult to determine, but an average may be assumed to be the expectation value of the forest when it is 40 years old. That is $2,450,000 discounted at 4 per cent. for forty years, or $510,310. Then if exemption were allowed for the first thirty years the collectible tax would be the accepted rate paid on that sum yearly for fifty years. It is manifest that the accepted rate can not be the same as that applied to the land—2 per cent. on a two-thirds valuation—for when continued for fifty years the sum of the taxes amount to nearly half the final value of the crop. Such a proportion is prohibitive, and it must be admitted that forests can not pay the high rates commonly levied on real estate—at least, not until the crop is worth relatively more than it is now. This fact is strongly emphasized if we ignore all rebates and allowances and say that the forest shall pay $1\frac{1}{3}$ per cent. of its value yearly. Eighty times $1\frac{1}{3}$ per cent. equals $106\frac{2}{3}$ per cent.; in other words, the whole crop would not pay the tax.

For the purpose of the present illustration, it may be assumed that the rate is one-half of 1 per cent., and, again, that money is worth 4 per cent. The total return at the time the timber is cut will then be $389,537, or about 10 per cent. of the stumpage price. It is possible that in some cases the county might claim more. The figures in any event would depend largely upon the length of time involved; but bearing in mind the importance of encouraging the owner to keep his forest standing, the proportion may be accepted as about what should be paid. The county is distinctly better off than it would be under the present system, for, instead of uncertain returns or no revenue at all, if the land were relinquished, it has the assurance of a reasonable yearly revenue from the land, and a lien upon the mature forest for a further sum which, discounted at 4 per cent., is equal to $706.65 a year.

This example does not pretend to be exact in any respect; it is purely illustrative; yet if the land value, the yield, and the in-

terest rate be accepted as reasonable, the following table will show that both owner and community are treated fairly. If the owner's profit appear too small for the risk involved it should be remembered that no allowance is made for a very probable advance in land and stumpage values.

Comparison of Tax collected and owner's profit from a forest of 50,000 acres yielding timber worth $2,450,000 after eighty years.

County's Interest.

Yearly revenue from land	$666 67
Yearly revenue from State	250 00
Yearly revenue from forest, calculated from final return	706 65
Total	$1,623 32

Or practically 3¼ cents per acre = 3¼ per cent. on a value of $1.

Owner's Interest.

Investment—	
Land at $1 per acre	$50,000
Capital to produce $666.67 yearly for land tax and $1,000 yearly for management	41,667
Total	$91,667
Receipts—	
For stumpage	$2,450,000
Value of land	50,000
Capital set aside to pay taxes and management	41,667
Gross total	$2,541,667
Less deferred tax	389,537
Net total	$2,152,130

Profit = 4 per cent. (about) compound interest on the investment.

CONCLUSION.

In conclusion, forest taxation is peculiarly a legal question which each State must consider individually and without interference from the national government. Any enactment must harmonize with the fundamental law and do justice to all interests. Opposition to any measure is sure to be encountered, and for that reason a radical proposition has some advantage over one which, like an exemption act, would seem to favor a class. Emphasis needs to be laid upon the point that whereas the ability of most

of the States of the Union to acquire forest reserves is limited by lack of revenue, those which contain the largest areas of private woodlands have the power above all others to keep the forest in those places that are naturally adapted to it.

From these considerationes it appears that the actual situation can be met only by accepting a principle in taxation which shall definitely recognize the public value of growing forests and in its application strive to maintain them as the sources of material needed in important industries and as valuable climate factors. This means that private property in forests should be taxed with reference to three considerations: (*a*) Necessity—the support of the local government; (*b*) equity—an assessment based upon the actual yield, collection of the tax (on the trees, not on the land) deferred until the crop is sold, and a recognition of the peculiar risks—fire, trespass, etc.—to which forests are subject; (*c*) encouragement—a special rating of the property to compensate the owner for whatever expense attaches to maintaining the forest in a condition that best serves the public interest.

How Should Our Future Forest Lands be Taxed?*

BY S. B. ELLIOTT.
Member Pennsylvania State Forestry Reservation Commission.

The following is a tardy compliance with a promise made several months ago to discuss in the columns of *Forest Leaves* the very important and pressing subject of taxation affecting the reforestation of the waste, barren and cut-over lands in our State. All observing persons, all land owners, and all those who have to do with the lumber interests of our country, know that as conditions now are no reforestation of those lands, whether naturally or artificially attempted, can take place while fires are allowed to devastate them or assessors allowed, as heretofore and now, to fix such values upon them and the young timber growing thereon, as may make it so unprofitable to the owners as to cause them to refrain from attempting it.

It is well known that in the past many owners of valuable timber tracts have been forced, from heavy taxation, to cut and throw their product upon a glutted market to save that product from practical confiscation; and this sort of work has done much towards bringing about the present deplorable state of depleted forests.

Forest fires can and must be controlled, and it is gratifying to know that public sentiment is awakening to the necessity of it that fires, especially upon State reservations, are less frequent. While it may seem hopeless now, awakened public opinion brought to bear upon the careless, heedless, offender, and the law upon the wilful one, will and must settle the matter without disagreement; but it is not so with the question of taxation. Regarding that men may disagree as their varied interests may be involved, but all should admit that taxation should be so adjusted that it shall be equal, just, and fair as possible, and the general welfare subserved.

*Reprinted through the courtesy *Forest Leaves*.

There is no tax for State purposes levied upon land in Pennsylvania, and whatever may be levied upon realty must, therefore, be local. The rate of such local taxation varies with the needs of the community, and only the so-called rural districts can, in the very nature of the case, place a tax upon land with young and growing timber on it. Therefore, any tax that shall fall upon land, consequent upon growing young trees thereon, must, necessarily, fall heavier upon rural districts than on towns and cities. That inequality should be relieved as much as possible, for the towns and cities require timber as much as the rural districts.

Article IX, Section 1, of our State Constitution, provides that "all taxes shall be uniform upon the same class of subjects." It is held that, under this clause, land can not be exempted from taxation, save where it shall be used for public purposes. This view is certainly logical and must be correct, and in the scheme I shall propose for relieving young growing timber from taxation, until such time as it shall reach an age wherein it shall have a commercial value when cut, will in no way conflict with that conclusion.

There can be no truthful denial that the assessor of the past (and he of the present time is of the same mind), persistently laid a heavy valuation upon all land having growing or standing timber upon it, and what he has been doing in the past he will be almost certain to do in the future, unless positively forbidden.

Our Legislature has endeavored to circumvent him to a certain extent by providing for a rebate of taxes, not to exceed forty-five cents per acre, on land which may have three hundred or more growing young trees upon it, but he promptly puts that rebate out of action by increasing the valuation on that or the remainder of the owner's holdings, and in this it may be reasonably expected that the county commissioners will uphold him. It must in some way be so fixed that it will be impossible to impose a tax on growing trees, or the owner thereof, until such trees have a value as a merchantable commodity if cut. Without that restraint no one need expect that land owners will plant or care for trees when they must wait half a century for returns on their investment and, in addition, endure increasing taxation besides.

But can this be done? Can we separate the products of the land itself for the purposes of taxation? It is an established principle

in taxation that land taxes may be measured by area, or they may be measured by rents—which, in a sense, is a product—or by value; and no matter which system prevails we primarily fix the value, in most cases, by what the land may produce. But suppose the rental or product of the land shall not be available in any possible way for half a century or more; can any one give a good reason why such rental or product should be subject to an annual and increasing tax?

That a tax should be levied and paid when the rental or product is received or becomes of merchantable value is not questioned nor proposed; but what is suggested is, that such an extension of time should be given as will permit the holder of the land to be in a position to realize on his, thus far, non-paying investment, and then tax for full worth as on other property. In other words, tax the land annually as land, according to the Constitution, but at no higher rate than if no trees were growing upon it, and when such trees arrive at a marketable age, and salable, if cut for any other purpose, then tax the trees, which are simply the product, as well as the land.

Do we separate the land from its products in the matter of taxation in our State? Most assuredly. The act of the Legislature referred to (see act approved April 20, 1905), practically does that by partially relieving the land of taxation. Timber growing on land may be assessed to one party while the land is assessed to another. The case is the same with coal—both products of the land. Whether timber of suitable age, or coal lying in the ground, should be taxed before removal for sale is a question not, at this stage of the argument, under consideration, but the United States Government, by act of Congress, permits dutiable goods to be stored in bonded warehouses without payment of duty until removed for sale, and the law is the same in certain cases where an excise duty—internal revenue—is not collected until the goods are taken from the bonded warehouses. But in regard to the timber trees referred to, the difference claimed between them and young growing ones is, that one is ripe, and now merchantable, if cut, while the other is not, nor can be for a long time, and the contention is that taxes should be levied until the growing trees shall have, at the time taxation begins, a then present value.

In this State we do not tax colts or young cattle until they are

four years old—an age in which they are esteemed to have a merchantable value. A farmer may thus make a business of growing young cattle and young horses and disposing of them without being subject to taxation at all. Thus is the product of the land separated from the land itself in taxation.

The value of young trees is purely prospective. It may never materialize. Fire, disease, or insects may destroy it. It has no marketable value until large enough for use, and it can not be conceived that our Constitution contemplates taxing non-existent or prospective values. It is real ones, actual ones, present ones that should be the subjects of taxation.

It is pertinent to remark that there is more or less land in every county in our State that is unsuited for the general purposes of agriculture—land from which all merchantable timber has been removed or killed by fire. All such is subject to taxation under our Constitution, and, as the law upon stands, any trees that may now exist there, or may come to grow upon it in time, may be considered by the assessor as having a value, when, in fact, the only value that can be conceived is a prospective one. The assessor may assume such value as he sees fit and add it, increasing it each year, to that of the land for the purposes of taxation. That in our present system, right in the face of the fact that no revenue can be received for many years, and the further fact that this prospective value may be wiped out at any time by fire or disease. At the very best, land devoted to tree-growing can not escape bearing a heavy burden. It should be placed in a separate class from that devoted to the general purposes of agriculture. A little computation will show how unequally it stands when compared with others.

It is certainly fair to assume that three dollars per acre is the net annual income from cultivated land after taxes and all legitimate charges in cultivating have been considered. In forty years —the time required for nearly all our valuable timber trees to grow to be at all suitable for merchantable timber, and most of them require sixty or more years—the sum received will amount to $120. As the owner gets the money each year he has the use of it, and it is but right that interest should be added. Simple interest of five per cent. would increase the sum to $240, while

compound interest—and that is what should be reckoned—would make it amount to $376.14.

Now, take an acre upon which trees shall be planted. No income at all equal to cost of planting and care, up to forty years, can be received, except in the case of one or two species of quick-growing trees used for special purposes, and, should no additional tax consequent upon the growth of the trees be put upon it, and a tax of only three cents per acre be levied upon it to meet the requirements of the Constitution, the owner will, in forty years, have paid out $1.20 in taxes, and putting compound interest on this the amount will be $3.76. One case shows a gain of $376.14, and the other a loss of $3.76, to say nothing of the use of the money invested in planting trees and caring for them. One shows an annual net return of five per cent. on land valued at $60 per acre that in all probability was not assessed at one-half of that amount, and the other a loss of three cents per acre on whatever sum you choose to value the land at. One must look in vain for uniformity here.

But what can be said in defense of adding to the burden of the timber land by assessing an assumed, prospective value upon it? If such shall be persisted in it will amount to absolute prohibition of reforestation in this State. Under the very best system that can be devised the owners of land will not be eager to engage in an enterprise that will take so long a time to materialize.

But can a better system than that now in vogue be devised? That is the problem before us, and it is a very serious one. Taxation is a profound and perplexing question, and, at best, must be a matter of compromise. However, the task of reforming our system will never be accomplished unless some plan shall be proposed, and, claiming that a better plan is possible, the following is put forth for consideration:

Let a board of competent freeholders of the county be appointed by the court, or elected for that purpose, whose duty it shall be to fix a valuation on any and all lands which the owners thereof shall elect to devote exclusively to growing trees of such species as are suitable for merchantable lumber. This valuation to be made every ten years, and in no case to be any greater per acre than the lowest valuation placed by the assessors on any non-agricultural, barren, treeless or waste land of any sort within the

county. An appeal to the court from this valuation shall be allowed any landowner, and, upon hearing, the court shall have power to determine the sum.

If any landowner, whether nonresident or resident, shall elect to devote any portion of his land exclusively to tree-growing for commercial purposes he shall give notice, in proper form, to the assessor of the district in which such land shall be located, and the assessor shall at once report the same to the county commissioners, who shall promptly lay it before the judge of the Court of Quarter Sessions of the county. Thereupon the court shall call upon the Department of Forestry of the State to appoint an expert in forestry, who shall at once examine the premises and decide whether they are suitable for growing trees of such species as will make good, marketable lumber, and to decide what species of trees shall be cared for, if any such are growing on the land, and also to decide what additional ones, if any, must be planted, and in all cases to determine how many and what species.

If the report shall be favorable, and the landowner become obligated to the county to conduct tree-planting and tree-growing on said land in accordance with the directions and conditions which the Forestry Department may formulate and exact, then, when so planted or devoted to tree growing, said land shall not be assessed at a higher rate nor taxed more per acre than the valuation set upon it by the board appointed for that purpose or the court, on appeal, had fixed, until the trees growing thereon shall be large enough to produce good, merchantable lumber and cut therefor. In case of planted trees this period of time shall not be fixed for less than forty-five years, except where quick-growing trees shall be raised for other purposes than sawed timber.

If, at any time, the owner of any such land shall fail to maintain, in some stage of growth, such a number of trees as the Department of Forestry shall deem requisite—a designation of such number to be furnished the county commissioners—then the land shall be removed from the list of tree-growing lands and subject to taxation as other lands in like condition are in the county.

Whenever the owner of any such tree-growing land shall deem it desirable to cut and remove any or all of the trees growing thereon, he shall apply to the commissioners of the county for a

valuation of such timber trees growing thereon as he shall elect to cut and remove for use or sale, and on such removal he shall pay to the proper collectors a total tax of not more than two per cent. on the sum fixed by the county commissioners. Appeal to the court from this valuation shall be at all times a matter of right.

If any trees shall be removed at any time in order to permit a better development of those remaining, the value of the trees so removed shall not be liable to any tax unless the value in the vicinity shall be more than the cost of removal or sale, nor shall such firewood as may be necessary for use in the owner's house, or the house of any tenant thereon, in his service, be liable to any tax.

The tax which may fall due at the time of cutting of said trees shall be a lien upon the same, and upon the land upon which they grow, and when the same shall be cut and removed the tax must be paid by the party so cutting and removing them.

Much detail is necessarily omitted in the foregoing, the object being to show, in a general way, a method to relieve tree-growing land from unjust taxation, yet give to the public fund its due and equitable proportion of tax on property when that property becomes of merchantable value, but not before.

If putting a tax on timber when sold shall not be thought advisable, then when the trees shall arrive at an age when some can be profitably removed for sale, say at the age of forty-five years from the time of planting or electing to care for growing trees for lumber that may be growing on the land at such time, a certain portion of said land may become taxable as timber land now is. If, on arriving at the age of forty-five years, one-twentieth shall be set apart for such taxation, and a twentieth each year thereafter until all shall become taxable, an age of sixty-five years will be reached. Some of our timber trees will have then arrived at a suitable age for the manufacture of lumber; but if the owner shall not then elect to cut the timber he will be paying taxes on his land same as now. In this system there should be no tax levied when the timber is cut, for the tax began before that was fit and suitable for lumber.

But it may be said that in both these proposed systems the timber has all the time been growing in value, but has paid no

tax. True, but it has all the time been costing its owner money —the use of money invested in the land and in the planting of trees and caring for them, and he has received no revenue—nothing to pay taxes with. The same can be said of buildings or constructions for any purpose which may be going on for the improvement of property. But who claims the right to tax such improvements until completed, providing they are pushed forward to completion as rapidly as possible?

To suppose that our national and State governments will be able, from their limited holdings, to supply this country with the requisite amount of timber that our civilization demands is to suppose what can not occur. Individuals, municipalities, corporations, companies and trustees of estates must engage in tree-growing, and that speedily, or there will be so disastrous a timber famine that the car of progress in this country will not only not advance, but will go backward. Some relief and protection to tree-growing must be given or it will cease. Whoever may engage in it will suffer enough in waiting for it to mature and in tieing up money invested in the enterprise, and should be exempt from taxation in any form. Full relief can not be given under our Constitution, and it should be amended. It should conform to the changed condition of things. With us tree-growing is new. It is unlike any other enterprise, because of the long period of time taken to bring returns. At present only such relief as has been here suggested, or in some other form which will prevent confiscation, can be given by our State. But the government of the United States can and should aid in the matter. A bounty on tree-growing would be of far more benefit to the country at large than a bounty on beet sugar, and a free distribution of tree seeds and young trees of equal, if not greater, benefit than free garden seeds.

Note.—Since writing the foregoing, I have discovered that Dr. J. T. Rothrock, former Commissioner of Forestry of Pennsylvania, now of the Forestry Commission, held substantially the same views of the injustice of taxing growing timber that I have set forth. This he did in an article entitled "Vanishing Industries," published in the Report of the State Board of Agriculture for 1894, page 223, a part of which is here given. I make this reference with great pleasure, as he thus saw, in the early days of the forestry movement, what must sooner or later be met. I was not aware of this declaration by him when I sent you the article, or I

most certainly would have given credit to this worthy pioneer, whose clear vision saw what should and must be done.—S. B. Elliott.

"As for the taxation of standing timber, one may as well come out on a distinct platform at once; it is a wrong, both to the owner and to the commonwealth, but chiefly to the latter. It is false in principle, for it taxes a man for a benefit which he has not yet received. If a timber owner holds land twenty years and then sells it at an advanced price, he then receives his increment and income, for both of which he should pay. So also he should when he realizes on his investment by cutting the trees. But, taxing standing timber is not only false in principle, but is pernicious in its results, because it is confiscating (practically) the lands, to avoid which the owner cuts the trees, and so inflicts an injury (as things now are) on the State. There are known methods of doing this.

"It is objected that if growing timber is exempted from taxation it would work a wrong to the poorest counties, because it would leave them without requisite funds for opening and repairing roads. This, of course, would be bad enough, but is it any more than taking the taxes and failing to repair the roads? The argument may prove too much.

"Let us look just a little down into the future: This good-road question is a rising one. It will not down. It has come to stay, and we may frankly meet the issue. The State requires ready means of communication from place to place. Without them we should be largely at the mercy of the railroads. In proportion as these are good we are less dependent of the railroads.

"Now, is it not possible that we should be taking a step on which the wisdom of the future would pronounce favorably if we were to do this?

"Remove the tax from standing timber until it is sold and cut. And whatever revenue a township loses, by thus exempting the timber, let the State restore, to be expended under competent supervision in maintaining a proper road system in that township.

"It will be observed that this grants the largest aid just where need of development is greatest, and that the State helps itself as much, or more, than it helps the townships."

Huge Consumption of Wooden Fence Posts.

In the Middle West, Where Trees are Scarce, It Will Pay to Grow a Supply.

The difficulty of obtaining fence posts at reasonable prices has given an impetus scarcely realized to forest planting in the Middle West. Newspapers, farmers' institutes, women's clubs, and boards of trade throughout the region are pointing out the need of such material, and dwelling on the profit realized by the few men who planted trees years ago and whose plantations have been successful. The local supply of all forest products is insignificant, and timber, if not grown at home, must be imported. With the continuous retreat of the sources of supply under the attack of the vigorous demand, the length of the haul increases and the cost of transportation rises higher and higher. Yet the fields and pastures must be fenced. The posts must be had.

The annual production of fence posts in the regular logging camps of the country, as reported by the last census, is 8,715,661. How many times greater than this is the annual cut from the home woodlot no figures exist to show; but by taking the total number of farms and their acreage and making a conservative allowance for posts for the fences inclosing each farm, it has been estimated that upwards of 1,000,000,000 posts are set each year. Such figures are too vast to mean anything. Even the nine million posts of the census, a mere drop in the bucket as compared with the unreported production, would, if set 15 feet apart, girdle the earth, or woul build a solid pile 55 feet wide, 40 feet high, and a mile long.

Durability and at least moderate strength are the desirable qualities for fence posts. The use of species which are not durable is expensive, both on account of the more frequent renewal which is necessary and because repairing is constantly called for. Timber of the required quality is produced in the Middle West by hardy catalpa, black locust, and Osage orange.

Catalpa makes an excellent growth on deep, porous, fertile soil,

but only on such soil. Five or six inch posts should be ready to cut in about ten years. In regions immune from the locust borer black locust will yield satisfactory returns from soil in which catalpa would fail, and for this reason it is adapted to a wide area where the rainfall is light. Under ordinary conditions, locust should produce fence material in fifteen years.

Osage orange is not exacting in its soil requirements. It is being extensively planted for hedges and windbreaks, from which a considerable yield of fence posts may be obtained. It makes satisfactory growth on dry soils, and reaches post size in from fifteen to twenty years.

Several other species, such as white willow, European larch, Russian mulberry, and red cedar, are also being grown with good results, but none of them is better fitted to supply fence posts than those first named.

The Forest Service fully recognizes the importance of fence posts in farm economy, and the great demand for suitable timber. Studies of the growth and durability of various species have been made, and the limits of the commercial planting range of each has been more closely defined. Rapid-growing species which are not durable have been studied to determine some form of preservation treatment which will increase their durability. Further work along this line will undoubtedly add largely to the list of species which can furnish the desired product.

Nut Growing and Forestry.

BY LESLIE HARRISON.

One of the main causes working against the immediate adoption of forestry is the distant future of the returns. American civilization lives too much in the present, and it is hard to persuade the average man to sacrifice himself in the interests of a posterity some generations removed.

But there are certain trees which are now and always will be valuable for their timber, and which also bear paying crops long before they are available for the sawmill. Chief among these are the chestnut, walnut, and hickory. There are a number of other valuable nut trees, but their cultivation has come into the realm of the orchardist, as is notably the case with the so-called "English Walnut" and almond in California, and the pecan in Texas.

Little has yet been done in the improvement and cultivation of our native nuts, especially those borne on valuable forest trees. Much attention has been given to the orchard varieties, but when our indigenous nuts have been improved it is probable that they will be even more in demand than some of the more important carefully cultivated nuts of the present day.

The chestnut has received some attention, particularly in Pennsylvania and New Jersey, and it is deserving of considerabl more, for its main value lies in the fact that it can be used on rough upland country where the possibility of other crops would be at a minimum. Moreover, it has been successfully demonstrated that imported and fancy varieties can be grafted onto native hardy stock to produce fine nuts in great profusion. The different kinds of hickory and walnut need lower lands, but even these trees can be successfully grown in bottom lands whose frequent overflow renders them unfit for farming purposes. While these varieties are growing they are not only producing a valuable timber stand for the future, but in the present they incidentally

furnish a valuable by-product in the nuts grown, making such plantations valuable properties long years before they mature for lumber. By this plan annual harvests will pay the expenses of forest operations, and the man who plants these hardwood trees has a reward in addition to the feeling that his children will have a valuable inheritance in the timber.

Mr. E. A. Sterling, of the U. S. Forest Service, in a report furnished to the New York Forest, Fish, and Game Commission, recommends highly the cultivation of chestnut groves, basing his recommendation on actual observations of groves in New Jersey and Pennsylvania. In these two States chestnut culture has been tried in two ways; in groves of actual forest growth under forest conditions, and in orchards under orchard conditions. The former method is a complete success, and in its utilization of waste land takes nothing from areas which otherwise might be profitably devoted to the cultivation of other crops. In the latter method the chances of failure seem to be greater, and in case of a failure there is not only the loss of the crop itself, but the loss of the use of the ground on which the attempted crop was grown. The most successful method in use was the grafting of Japanese, European, or desirable native varieties on the coppice growth on cut-over chestnut lands, thus insuring in the second growth a maximum annual crop value in a minimum time.

It has been found that the Paragon is the best variety for grafting, and these will be in bearing in four years, with an annual increase in the value of the harvested crop. There is no trouble in disposing of the yield, as the demand is far in excess of the supply. The best Paragon nuts sell readily at prices averaging $10 per hundredweight, and a usual price is $7 per bushel. While the trees do not produce phenomenal yields in their early years, especially if many of the burrs are removed in order to get improved quality and size of nuts in the remaining ones, still the yield of older trees is enormous, single trees giving $40 worth of chestnuts.

It is probable that the success attained by the Pennsylvania groves will tempt others to make use of worthless old hillsides to produce a crop of nuts as well as timber, and under such conditions the work forms a branch of forestry rather than horti-

culture, since the essential elements of the forest are all there. More than that, chestnut culture should go a long way in solving the problem of reclaiming worthless burned and waste land, which at the present time is a standing menace to surrounding forests. In addition to this it provides for a more complete utilization of forest areas.

Suggestions for State Forest Fire Laws.

BY E. J. CHEYNEY.
Minnesota Experiment Station.

The forest laws of most of our States are far more impressive in the reading than they are effective in the application. There are at least three glaring weaknesses—almost universal in their occurrence—the correction of which would make all the other shortcomings of the laws seem trivial indeed.

In the first place, the legislatures—led by what is probably a false idea of economy—would all seem to have the bee by the wrong end. The laws are nearly all directed toward the fighting of fires which have already started in the woods, providing dire punishment to be visited on the heads of those who are supposed to have set such fires, and giving promise of horrible things which will be done to any district attorneys who do not properly prosecute such offenders. To this end a grudging and usually inefficient appropriation is made for fighting fires. Many of the laws simply appoint fire wardens, without pay, empowering (?) them to fight fires and hire help for that purpose, without making any appropriation whatsoever.

These laws are a good thing. Not only does it show that people are waking up to the necessity of such things, but they are of practical value in providing men where they are very badly needed. It would, however, be much better to look to the prevention of fires, so that there would be no necessity of fighting them. The old adage that an ounce of prevention is worth a pound of cure applies nowhere better than to forest fires. And would it not be possible to bring this about with little or no increased expense to the State?

Under the present system a fire warden is paid only for the time spent in actually fighting the fire. He can not afford to neglect his own work to look for fires in the places where they are most likely to occur, nor even to waste an afternoon in hurrying to inspect a rumor which may turn out to be a false alarm, and consequently no pay. In this way a fire almost necessarily grows to dangerous proportions before anyone can afford to take any

notice of it, and a large number of men are then required to fight it.

Every forest fire has a small beginning, and a very large per cent. of these beginnings would be found by a man who was paid to look for them; and would be found in such time that he could put them out alone with the aid of one or two helpers. Without looking into the value of the property which would be saved in this way, it is an open question whether a paid regular patrol would not nip in the bud a sufficient number of fires to make that plan actually cheaper than paying the crowds of temporary laborers who have to be called in at extra high wages to fight the fires after they have gotten well under way. For example: It would not require a very large fire to force a warden to hire thirty men for two days at $2 per day. One hundred and twenty dollars is spent in putting out this one little fire, which has, nevertheless, done considerable damage before it was gotten under control. That $120 would pay one man to patrol a large territory for three months of the summer danger season—April, May, and June. Such a patrol would probably have caught this fire—together with dozens of others—in the incipient stage, saved several thousands of feet of lumber, and the expense of several hundred fire fighters.

That millions of feet of timber would be saved in this way is beyond question, but would it not also be cheaper in the actual cash outlay?

APPOINTMENT OF WARDENS.

Another mistake, though not nearly so important as the first, is the appointment of elected men, such as the Selectmen of a town, to the position of fire warden. A man will not leave his own work to go fight a fire on some one else's ground and probably for some one else's benefit unless he has to, and forcing men to do such things is not a business calculated to make a man popular. Consequently the elected fire warden is not going to do it, or can he be greatly blamed for refusing. He does not care about losing the position as fire warden, but the more paying or more honorary position by virtue of which he is a fire warden. One or two of the States have realized this and found a very good solution of it in the appointment of the wardens by the courts.

THE MATTER OF PAY.

This difficulty which the fire warden has in obtaining aid in time of fire—a question which seems to puzzle some people unduly—is the result of another great weakness in the fire laws. They usually offer higher pay than is given for other work, but men do not volunteer for their work. The causes are not far to seek. The job is a peremptory and temporary one—which does not matter so much, though both these characteristics go against the grain of the average American—and the pay comes somewhere in the far future—which matters a great deal. To the class of men hired on such occasions pay in the future is no pay at all; they would rather work for fifty cents and get it at once, than for two dollars to come a month hence. And lucky is the man who gets his money through the government red tape in a month! The Pocono Protective Fire Association, in Pennsylvania, though they do not pay as high wages as the State, have no trouble in getting men for this work, because they pay cash. This has been pretty generally acknowledged as a great fault, but nothing has been done to remedy it.

I would like to suggest the following plan: The length of time taken to get the money from the State treasuries is largely the result of the cumbrous working of those institutions, and therefore unavoidable. But why not have a sub-pay station in the shape of the small country stores? Arrangements could easily be made with such stores, without expense, to credit the order of the fire wardens. These orders could be made out on the grounds immediately after the work was completed, taken to the neighboring store, and there either exchanged for cash or credited on the books. The stores would be willing enough to do this for the increased trade which it would inevitably bring them, and could wait for the slower pay of the government. Probably many orders are now cashed at the stores at a tremendous discount; an agreement between the store and the State would secure full pay for the holder. To make this system secure against leakage the wardens should be paid and bonded men, but the small amounts of money involved and the caution of the stores would act as a pretty good check on any fraud.

This would seem to be the most effective way of bracing up a weak system, which is the next best thing to getting a new one.

The Rise in Lumber Prices.*

BY R. S. KELLOGG.
U. S. Forest Service.

Ours is pre-eminently a wood-using civilization, and aside from food and clothing, no material is so essential to industrial progress as wood. Nature provided us with immense areas of easily accessible, highly valuable forests, and we have drawn upon them with so lavish a hand for every conceivable purpose that we are loath to believe that the time is rapidly approaching when our remaining forests must be handled constructively and not destructively; or else wood of the higher classes will be obtainable only in insufficient quantity. According to the census of 1900, which was admittedly incomplete, we were then using annually thirty-five billion feet of lumber, and now the amount is probably nearing fifty billion feet. Yet how many of you ever stop to consider that the lumber cut is much less than half of the total annual drain upon our forests? The pulp mills take some 2,000,000 cords of wood yearly, the tanneries 1,500,000 cords of hemlock and oak bark, the cooperage industry a vast amount of timber, the railroads about 115,000,000 ties for renewals alone, and then there are millions of posts and poles to be added to the total before we even come to the half of our wood consumption. The census of 1880 showed that the wood used for fuel at that time amounted to 146,000,000 cords, and there is no reason to suppose that, despite the great increase in coal consumption, the 85,000,000 people of 1906 are burning less wood than did the 50,000,000 of 1880.

All these items, huge though they be, belong to necessary demands upon the forest. We are a rapidly growing nation, and we have seized upon every available resource to aid in our growth. Though the forests have been destroyed, they have yielded rich returns. Yet there is another drain upon them, which has been wholly harmful. This is fire. As a single example: The sec-

*Paper read at the Sixteenth Annual Meeting of the Southern Lumber Manufacturers' Association at New Orleans, January 23, 1906.

retary of the Pacific Coast Association recentely stated that during the last fifty years there has been 900,000 acres more timber burned over than cut over in Oregon.

In the early days New England was the great lumber region. Then came the Lake States with their supposedly "inexhaustible supply" of timber. This was said thirty or forty years ago. Now, Michigan is a practically negligible factor in white pine. Wisconsin is on the wane, and it will not be many years until Minneapolis and Cloquet cease turning out a million and a half feet each daily during the sawing season. Southern yellow pine is at present furnishing in the neighborhood of 30 per cent. of the total lumber supply, but it in turn will yield to the Pacific Coast woods; and we have finally come to the realization that the so-called "inexhaustible supply" is a pleasing, but most dangerous misconception. Exploitation has been so easy, invention has supplied so many ingenious methods of converting trees into lumber, that the output from a given region is maintained at a high level until the supply is close to the point of exhaustion. We are nearer a halting place than most of us realize.

What is the condition confronting the lumberman and the user of his products today? Dr. Fernow states that an "extravagant estimate" of our stumpage is not over two trillion feet standing on some 500,000,000 acres. At the present rate of sawing this will be cut in forty years. This does not mean that forty years hence there will be no more timber to saw, but it does mean that there must come a great readjustment to new conditions by both the manufacturer and the user of forest products. So far we have been drawing on the older trees in our forests, or cutting virgin stands anywhere from 100 to 500 years old. In other words, we have been paying dividends out of our capital stock, and no good business man will do that. In the near future our wood must be supplied by growth and reproduction, and the now commonly despised "second growth" will come to be our source of supply.

Going back to our estimated forest area of 500,000,000 acres, let us see what can be done with it. Of this 500,000,000 acres, the government has nearly 100,000,000 acres in national forest reserves, but a considerable portion of this area lacks forests of

any value for lumber. Four-fifths of our forest area is in private hands, and quite likely will remain so for at least a long time to come. The highly managed forests of Germany grow, on an average, about 50 cubic feet of wood per acre annually. Were our forests in the condition of the German forests, their extent is barely sufficient to furnish by annual growth the amount of wood we now use. As a matter of fact, the annual growth of our forests as a whole, under present conditions of abuse, is probably not more than one-fifth that of the German forests.

These, then, are the conditions as nearly as can be estimated today. It does not require any special gift of prophecy to outline what will follow. We will undoubtedly go on in the same old wasteful, extravagant way, for some years yet, until there comes a stern realization that things must change. And when I say a "stern realization," I mean one which is caused by a greater scarcity of stumpage and a much higher price for lumber than now exists. Then we shall begin to husband our resources, and make one board do where we now use two. Undoubtedly we are approaching the maximum of our annual consumption of forest products, and hereafter the great increase will be in value instead of quantity. It is entirely possible for us to use less wood, and we shall do so when we have to. We are consuming some 500 board feet of lumber, per capita, annually, where Europe uses but 60; and if we were forced to import 80 per cent. of our wood supply, as does France, or practically all, as does England, we should quickly learn how to economize. We are not likely to reach this extreme condition, but we may be sure that prices will advance until consumption is finally forced down to somewhere near the annual accretion of the forests that are left at that time.

I do not decry high prices, much as the country has benefited by low prices for lumber. I recognize the fact that in general the lumbermen have operated as economically as they could under prevailing conditions, and while it is fashionable to condemn them for destroying the forests, they have done so only because of economic demand, and their critics would have behaved no better under the same circumstances. But the forests will not be handled rationally until they become valuable, until there is money in handling them that way; and so I say that from the standpoint

of the forester, high prices for lumber are a good thing, because they make it profitable to utilize the forests rationally and economically. One of the prominent Pacific Coast lumbermen recently advised his associates to "slab lightly, reduce your saw kerf, and keep your eye on the burner." Carrying this a little further, it will not be long until the slabs are resawed and the burner abolished entirely, as the white pine manufacturers are now doing.

In view of these conditions, there is nothing really surprising in the fact that in the last twelve years the price of rough white pine uppers on the Buffalo market has risen from $47 to $91, or 94 per cent.; that select cypress on the New York market has risen from $30.50 to $42.40, or 39 per cent.; that hemlock, Pennsylvania stock, at New York, has risen from $11.40 to $22.25, or 95 per cent., and that according to your price lists, "A" flat-grain yellow pine flooring was quoted at $16.50 in 1894, delivered on a 22-cent rate, and at $29.50 in December, 1905, delivered on a 23-cent rate, or a raise of 77 per cent. Of course, I understand that there are a number of factors entering into the case, and am not overlooking the influence of the general rise in the price level during the past few years, the abundant crops, and the great building activity, but it requires more than these things to explain why it was that your Committee on Values issued six price lists in the effort to keep up with the market last year, and that there is little sagging in the latest list during this winter. It is entirely possible and even likely that there will be temporary halts and even depressions in prices of lumber, but there is every reason to believe that the upward course shown by the price-curves for the last dozen years is but the beginning of a general advance which will continue until an equilibrium between the demand for wood and the amount available for the yearly cut is reached on a far higher price level than at present.

Recreation and the Forest.

Men work that they may enjoy leisure, and make money in order to spend it. This is not, perhaps, the normal and proper state of affairs, and it may be that work for its own sake should bring rewarding enjoyment. But as the world goes, work may mean overwork, or work without real choice or aptitude, so that what might otherwise be a pleasure is too often a dry task. Recreation, therefore, though it takes up but a short span in the course of a lifetime, is cherished in proportion to its brevity. If the world had no natural recreation grounds the ordinary man would lack incentive to labor, except to supply the bare needs of existence. For the play instinct, the delight in free activity for its own sake, especially in the great outdoors, is as old as the race and one of its best inheritances from its prehistoric ancestry.

The forest is the most ancient and momentous of human dwelling places. Ever since men, in caves and trees, learned, even among dangers, to regard the forest as a home, the shadows, the silence, the excitements, and the fascination of the forest have stirred the strongest feelings of the race. Dread of the forest, its incentive to achievements, the sense that within it all things good and evil were to be found and treasured or encountered and overcome, have left an indelible impress in the minds and hearts of men.

In primitive days, when the business and risks of life were over for the day, the stern and impressive realities could be rehearsed by the hunter and his children in the mimic world of play. Nowadays, the ordeals of our forest ancestors have become all play. Hunting, picnicking, canoeing, fishing, tramping, the tent life and the roaring campfire are all survivals of the life of the Forest Age, reminiscences coursing in the very blood of our civilization and carrying us back to the times when danger was a part of the day's work and successful craft against bird and beast and fish was the first condition of existence. Recreation in the forest is the pleasant recall, in imagination, of a life vivid, fresh,

free, and heroic. This life, now lost to us in the humdrum barter of the market place, may be brought back by the power of money, to amuse and invigorate and thrill us yet in our short hours of leisure and liberty.

How highly this reversion to the old life is treasured may appropriately be measured, in these times, by the sacrifices men make, the money they spend, for a summer's outing beside forest and stream. In New Hampshire, for instance, about half a million dollars are spent each year by the summer visitors, whose choice of this region is based upon its fine woodlands and lakes. Of the 174,280 persons spending their summer there, in the latest year for which figures are at hand, only about one-tenth (20,352) occupied cottages for the season, while a third remained but a week or so, and more than half (95,706) remained less than a single week. The cash received from these people, in the same year, was almost $5,000,000, and the total amount of this business added to the capital invested in summer resort property exceeded $10,000,000.

Had the forests been destroyed or disfigured by wasteful logging, probably not one cent of this large income to the State would ever have been spent. Common sense, not sentiment, must make the strongest protest against any use of the New Hampshire forests, save one consistent with retaining forever the attractive power of the whole region for those seeking recreation. Of course, this "summer people" revenue is only a subsidiary affair in a business sense. The forests are chiefly valuable there, as elsewhere, for their ability to supply use and profit in the concrete of wood products. But the two values, the commercial and the pleasurable, may be secured together. The farmer whose yearly income is greatly augmented by the recreation his guests are sure to find in the forest which he owns, need not withhold the axe altogether. His woodlot may be made to pay by oft-repeated cuttings, which yield wood for home use or for market, without so thinning the stand as to mar the shade or pleasantness of the picnic grounds. Besides, by clearing the woodlot, though the first returns would be greater, he would have to wait long for further revenue; not only would he, in effect, turn away the paying guest, but he would discount the future.

Rules for the farmer's woodlot management in this region would be to avoid cutting of any kind during the summer outing season, to have strips of woods along the roads, to leave undisturbed the favored picnic grounds or places of special interest, and, in general, to avoid as far as possible, the clear cutting of any tract.

The same principles hold true even more emphatically of larger lumbering operations. These should go on; they yield a good part of the State revenue. But if pushed recklessly, as too often in the past, they will not merely invite their own end, but will put a stop to the quest for recreation in the New Hampshire hills. Moderation, wise and foresighted lumbering, will preserve both the direct and the indirect sources of revenue, and time will constantly add to their amount.

All this, which applies to the pocketbook alone, is important enough to lead to wise action without further discussion. But there is a broader argument of general policy which may be used in defense of the New Hampshire forests. Recreation grounds in the East are limited. More and more, as the cities swell, and the pressure of industrial life becomes severer, it is of the highest common concern that nature be safeguarded and encouraged in her beneficent work of building up and sustaining the great world of Recreation, in which care is thrown aside, and cramped limbs, bent shoulders, and weary brains may find freedom and invigoration. The forest for recreation has become a much needed investment in the interests of the whole community.

Forest Resources and the Public Welfare.

An Address Made Before the Annual Kentucky State Development Convention, Winchester, Ky., October 12, 1906.

BY HERBERT A. SMITH.
Editor, U. S. Forest Service.

We have lately passed through a half century of industrial development almost unparalleled in human history. In 1850 our population was 23,000,000, in 1900, 76,000,000. In 1850 our farm acreage was less than 300,000,000, in 1900 over 800,000,000, while the value of our farm property was less than $4,000,000,000, as against over $20,000,000,000 at the latter period. Our manufactures make a still more remarkable showing. The wage earners employed have risen from one to five millions, while the capital invested multiplied twenty times in the half century—from $500,000,000 to nearly $10,000,000,000. It is chiefly within this half century that our railroads have spread their network over the land, and steam has revolutionized the whole world of industry. In brief, then, these fifty years have seen an immense expansion of agriculture coupled with the sudden growth of a colossal manufacturing interest, and naturally along with these an accompanying development of transportation.

Who can doubt as we seek to read the future in the light of the present, that the first half of the twentieth century will see a progress equally notable? By 1950 we bid fair to be a nation of 200,000,000 souls. We have covered the land with our farms, yet it is now apparent that we have no more than scratched the surface of its productive power. By the use of irrigation we may plant empires in the desert, while by improved methods of cultivation we have it in our reach to increase the yield of our present farms many fold. Our manufactures are still increasing at a rate that staggers the imagination to keep pace with, and instead of having to supply our needs from other countries we are invading the markets of the world. Electricity promises to rival in the next half century the marvels which steam wrought in the last, while our vast supplies of iron and coal, the two main pillars of

present-day industrial supremacy, insures us such an immediate future as no other nation can hope to rival.

Yet there is another class of considerations which demands our attention. One of our most sagacious men of affairs has lately been calling to our notice the danger of exhaustion of many of our resources upon which prosperity depends. The very rapidity of national growth of which we are assured—which we can not escape—enhances the danger. By the end of the half century our vast deposits of iron will (so it is said), under the accelerated drain, have been very largely reduced. Our dwindling forests have already begun to harm the industries dependent on them. Our coal, the chief source of the power which drives the wheels of industry, can never be burned but once. Can it be that the vast rising structure of our industrial life is consuming its own foundations and is doomed to eventual downfall?

That same sagacious man of affairs to whom I have just referred —Mr. James J. Hill—has pointed out the distinction between our lasting and our transitory sources of prosperity. Our farms belong in the first class; our mines in the second. Every ton of ore taken from our mines is like money drawn from a bank account; when it is used it is gone. For stable and permanent prosperity, if our national greatness is not to fall into an early decay, we must look to those sources of wealth which are capable of utilization without impairment of their productive power.

There is a fundamental difference between utilization and exploitation. Mere exploitation brings temporary enrichment followed by permanent impoverishment. Exploitation is too often regarded as development. True and lasting material development depends on our learning to make the most of every natural resource. Undeveloped, our resources are but potential wealth. The greatness, prosperity, and power of our country, and with them our own individual welfare, depend on our learning how to utilize to the fullest every natural resource.

Of these natural resources our forests constitute one of the greatest. Hitherto we have abused this resource shamefully. We have exploited it. With the prodigal recklessness born of abundance we have taken what we needed and destroyed much more than we have used. It is now plain that the day of reckoning is not far distant. Not our children, but we ourselves, are likely

to have brought forcibly home to us the evil consequence of our shortsightedness.

In this problem forestry plays an important part. A considerable portion of our land is by nature fitted to serve its best use as a source of permanent supply of wood and water. In mountainous regions wood is the only crop which the soil is capable of producing, but it is not merely in the mountains that the natural forest land is to be found. Even in our richest agricultural regions there is usually to be found more or less land too rugged, steep, wet, or infertile for agriculture. Eventually the woodlots of the American farmer will furnish us with a large part of our wood supply.

The Department of Agriculture exists at Washington to promote the best use of all kinds and classes of the land which forms our greatest national asset. The problem is essentially the application of the highest intelligence and fullest scientific knowledge to the work of making our land yield its utmost. The Department of Agriculture seeks for the farmer new crops, better seed, better methods of cultivation, improved methods of breeding and caring for stock, information as to how to market his product—whatever can make his farm more profitable. In doing this it is adding enormously to the capital value of farm lands.

It is no new statement, but yet it is one that can not be made too often, that wood is of basic importance in our industrial life. Other materials can not do away with the need of it. There is no great industry for which it is not important.

Take the case of Kentucky. More than one-half of her area is wooded. Lumbering adds yearly to the wealth of the State an amount which places it second among her great industries. Yet this is only a beginning. Kentucky is rich in coal, but coal can not be mined without a large supply of mining timbers. In many places the coal mines have already largely drained their supply of timber, and the management of the Cumberland Mountain forests for the production of such timber will probably furnish their best employment, and will be necessary in the interest of the mines themselves. The same thing is true of the railroads. Every tie laid in the track requires on the average two trees growing in the forest to keep it there. Through the northern part of the State the production of railroad ties from timber tracts and

woodlots will assuredly be one of the most profitable ways of utilizing the forest, and special studies along these two lines, mining timber and tie production, in these two different parts of the State, would therefore be of great value. By far the greater part of the lumber produced in Kentucky is hardwood, of which oak constitutes a large part. Upon the supply of this depend many industries. Distributed through the State are to be found vehicle factories, handle factories, tight and slack cooperage plants, box factories, veneer mills, and wood distillation plants. The manufacture of carriages and wagons alone represents an aggregate investment of over $4,000,000. The cooperage industry in Kentucky produces more tight barrel stock than any other State in the Union.

Forest destruction is already threatening the future of these industries. Recent reports from the National Tight Barrel Stave Manufacturers' Association show that their timber today is costing nearly four and a half times what it did ten years ago. The handle factories of Kentucky use large quantities of hickory. Only this week the papers announced that the scarcity of hickory timber was the chief subject of discussion at the opening of the annual convention of the National Association of Implement and Vehicle Manufacturers. These manufacturers see the need of the supply of hickory already in sight.

Industrial development throughout the South is now recognizedly dependent in large measure on the development of the water power furnished by the streams descending from the Southern Appalachians. Forest destruction has already sensibly begun to affect these water powers. A measure to establish a national forest reserve which will put a stop to this destruction and benefit at once the consumers of wood, the users of water power, the agricultural interests affected by the floods in nudation, and the harbors and navigable inland waters now injured by the deposits of silt and sandbars, was passed by one branch of Congress at its last session, and now awaits the action of the other branch. From the forester's standpoint there can be no question that this legislation, if enacted, will beneficially affect the development of every State which borders on the reserve. It is to be hoped that this reserve will include some part of Kentucky.

But the State needs more than action by the National Govern